BRAZILIAN AMAZON DEVELOPMENT AND THE FOREST-BASED SECTOR

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A floresta tropical da Amazônia
não é um obstáculo ao desenvolvimento
da região e sim o meio de alcancá-lo.
J.R. Nascimento, 1978.

CHAPTER I

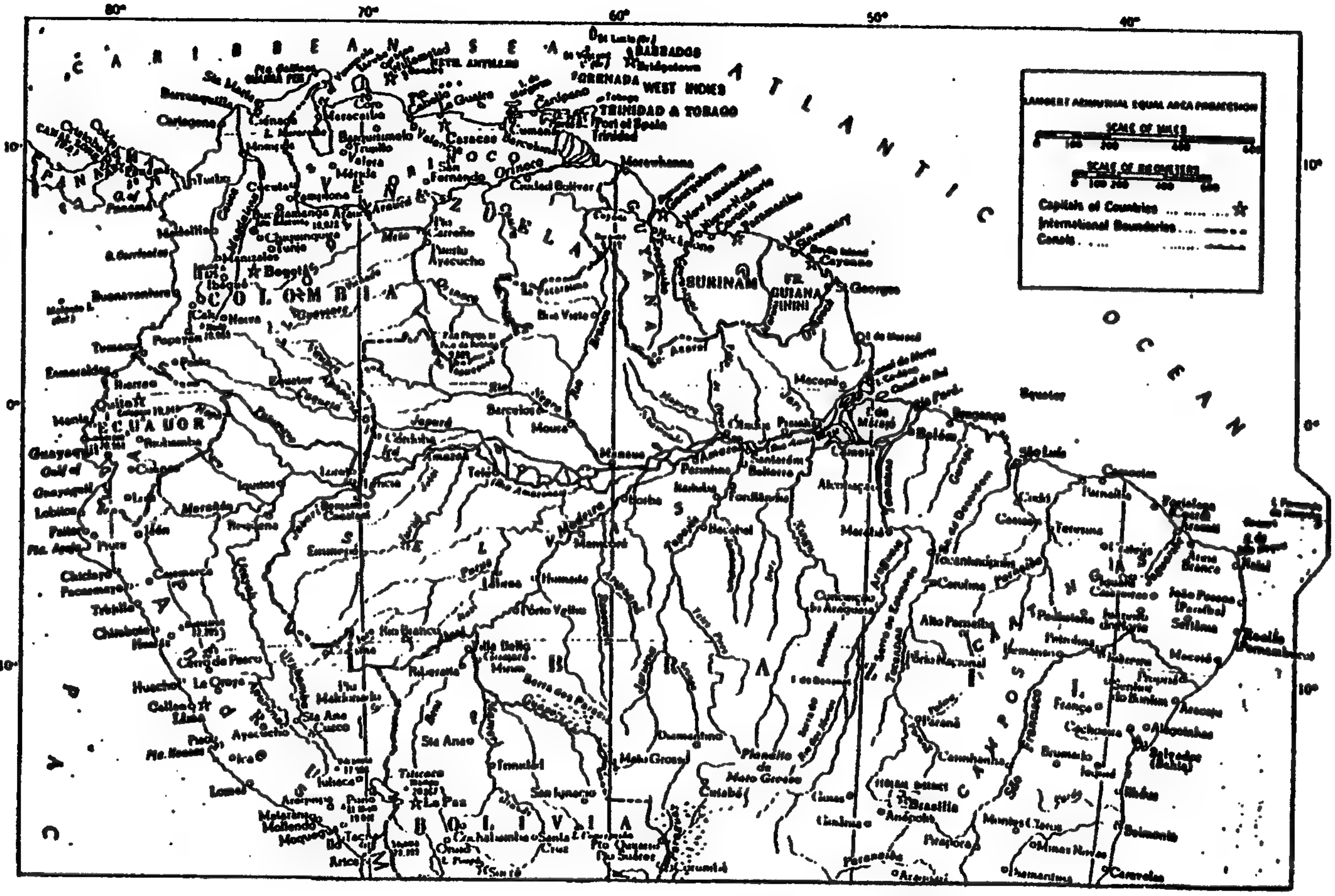
INTRODUCTION

The area of interest of this study is the Amazon Region of Brazil. There are several ways to identify this region and they are further discussed in the main body of the dissertation. Here it suffices to indicate that it is located in the northern half of South America, roughly corresponding to the Amazon River watershed. Figure 1 shows this part of South America and will be useful to the reader for geographic references.

The study concentrates on the portion of this watershed belonging to Brazil, which reduces substantially the number of socio-economic and institutional variables to be dealt with. Also useful for reference, figure 2 shows the map of Brazil with its current geopolitical division.

The study concentrates on the role of the forest-based sector in the Brazilian Amazon Region's development. There are also several ways by which a sector of the economy can be described. For the purpose of this dissertion, the forest-based the sector is here considered that part of society which is related to the use of natural

Figure 1: Map of the Northern Part of South America.



Source: Modified from G. & C. Merrian Co., 1977.

Figure 2: Map of Brazil Showing Neighoring Countries and Brazilian States, Territories and their Capitals.

Source: Burns, 1980: 11.

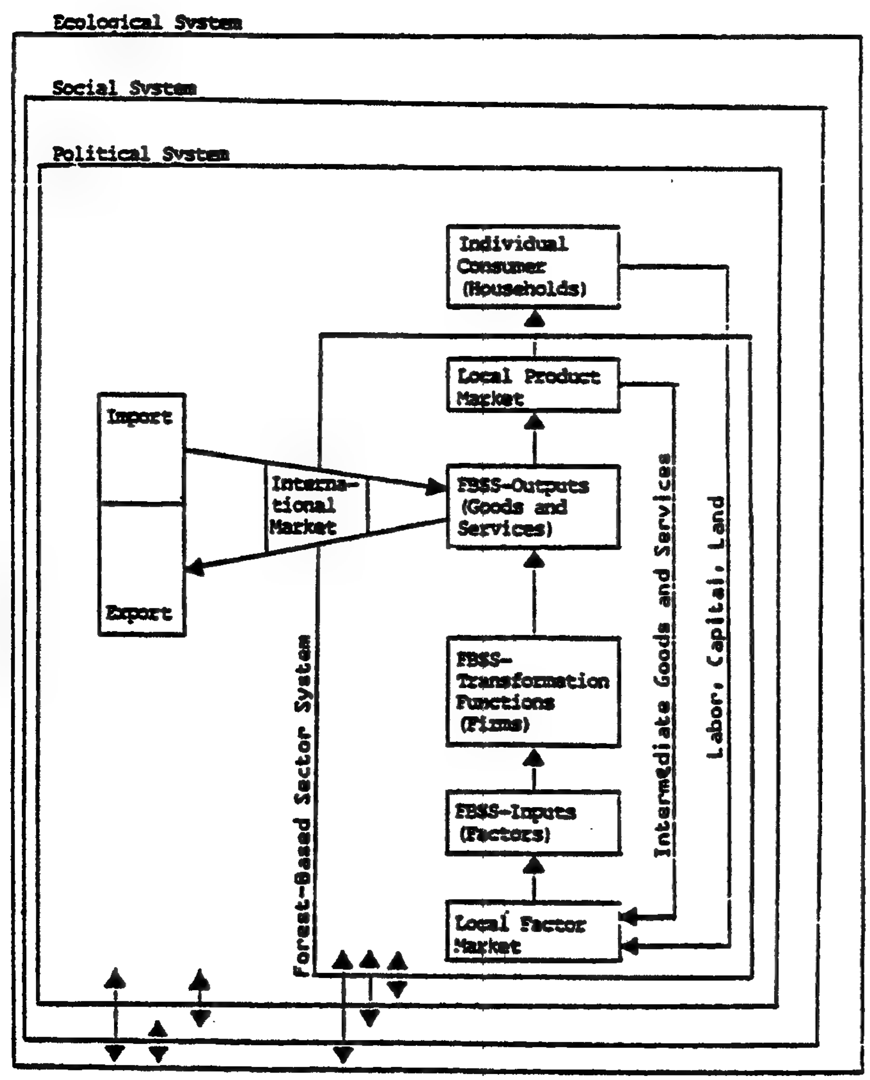
renewable resources. It relates especially to the use of native fauna resources (except fish) as well as flora resources, particularly the use of natural and planted forests.

Figure 3 presents the forest-based sector system (FBSS) as an open system which is part of the political, social, and environmental systems. The essence of the FBSS is represented by the three boxes named: FBSS-inputs, FBSS-transformation function, and FBSS-outputs. The resources used in the forest-based sector operations are represented by the FBSS-inputs box. Some examples of those inputs are: land, trees, machines, soil, pulp, fertilizer, energy, information, labor, seeds, water, and logs. Most of those inputs are provided by individual owners and they are either available within a society or they can be imported through the international market.

Some of these inputs are exchanged in a local (domestic) market and are transformed into forest products by the FBSS-transformation function. This function involves activities that may be divided in two main groups. The first group is constituted by activities which are mainly performed in the forests, referred to here as forest activities. They include, among others, those activities related to silviculture, watershed management, recreation, wildlife management, and logging. The second group includes activities which are performed in industries such as sawmills, pulp and papermills, and furniture making.

The goods and services produced by the FBSS-transformation function constitute the FBSS-output which can be: scenic views, logs, control of erosion, environmental preservation, genetic improvement of

Figure 3 : Forest-Based Sector Framework.



Source: Nascimento, 1983a.

trees, foreign exchange, wildlife, gums, firewood, recreation services, furniture, wildlife habitat, charcoal, money, water, paper, environmental conservation, healthy forests, fruit, nuts, plywood, employment, and others. Figure 4 shows various goods and services that the forest-based sector can produce. These goods and services help to improve the welfare of the members of society.

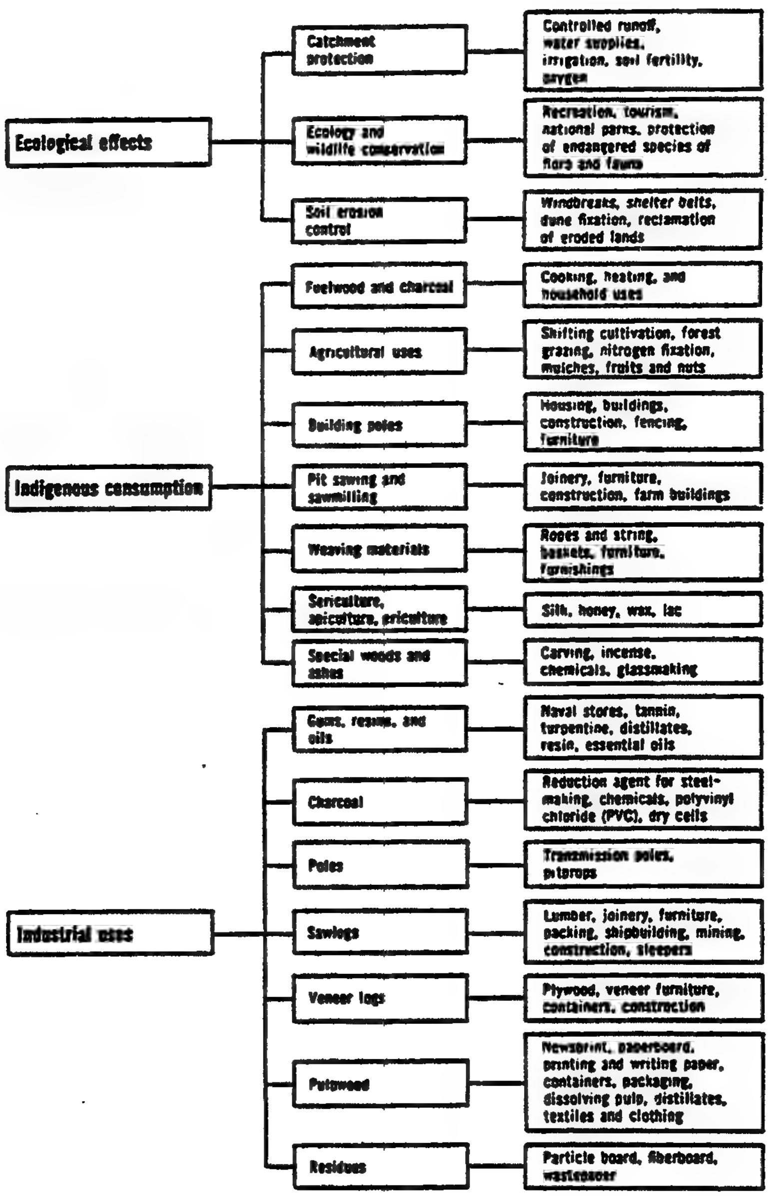
There is no clearcut distinction between the inputs and outputs of the FBSS. For instance, logs may be seen as either a forest output or an input for the plywood industry. Even though this distinction could be made, it is not fundamental for this study.

The FBSS-outputs in many cases can be exchanged in the local market so that individual consumers can satisfy their preferences. Some outputs can also be exported through the international market or they can be sold as intermediate goods to be used in the FBSS-transformation function. Other outputs are not exchanged in the market. Chapter VI examines the role of the forest-based sector in the development process.

Despite the presence of large quantities of forest resources in the region, it is surprising that the forest-based sector has not contributed more significantly to the development of the Brazilian Amazon.

Historically, forest-based production has been the most important income generating activity in the region. But this economic importance of the sector is only relevant as far as one is concerned with the Amazon Region. That is, in terms of its participation in the

Figure 4 : Forest-Based Goods and Services.



Source: World Bank, 1978: 16.

national economy as a whole, its contribution has been less dramatic, except during the rubber boom period. However, even in the most recent years of the Amazon economic history, the wood processing industry is, in relative terms, the industry which employs the greatest number of workers. Nevertheless, the Brazilian government, especially in recent decades, has paid relatively little attention to the past, current and potential role that the sector can play in the development process of the region. The sector has not, for the most part, been considered as an alternative for the region. In fact, the Amazonian tropical forests have been seen by decision-makers more often as an obstacle to the region's development than as a means to approach it.

This dissertation attempts to make an examination of the socio-economic development process of the Brazilian Amazon Region and of the past, current, and potential role of the forest-based sector in this process. For this purpose, the study is organized into three main parts. Part I provides a basic background understanding of the Amazonian ecosystem. This understanding is important because of the region's peculiar characteristics which condition human activities and, therefore, should be considered when socio-economic development of the region is studied, especially forest-based development. Part II is intended to discuss the Amazonian sociosystem concentrating on the Brazilian Amazon development process and how the forest-based sector has participated in it. The Amazonian sociosystem is presented through a discussion of the socio-economic history of the region and the interactions of man with its ecosystem. Part III, the last part,

examines the role of the forest-based sector in the development process, discusses some forest related basic issues identified in parts I and II and summarizes the study. The following paragraphs summarize the contents of these three parts.

Part I, which discusses the Amazonian ecosystem, has been divided into two main chapters. The first, chapter II, concentrates on the abiotic components of Amazonia's ecosystem and is divided in four sections. It starts (section II.1) by discussing the natural history of the region in a geological time context concentrating on the events that affected the development of the region's ecosystem. This section concludes by presenting the current geologic and geomorphological characteristics of Amazonia. Section II.2 discusses the basic climatic features of this tropical region, including: temperature, cloudiness, precipitation, humidity, and seasonality. It also discusses the relationships of these features with the region's geomorphology and vegetation. Finally, this section presents several climate classifications for the region. Section II.3 presents the basic characteristics of the Amazon River Watershed including of the Amazon River, its tributaries and of the floodplain areas--varzea. The last section, II.4, discusses the Amazonian soils.

Chapter III concerns itself with the biotic components of the ecosystems and is divided in two sections. Section III.1 discusses the Amazonian tropical forest and its functioning. It puts these forests in the context of the world's tropical vegetation and presents data on the types of vegetation found in Amazonia. It also discusses the

biological diversity found in the region and the different theories devised to explain it. Last, it tries to explain the complexity of the funtioning of the Amazonian tropical forest ecosystem, including the relationships between fish and forests, and explains the apparently paradoxical presence of the luxuriant tropical forests over generally poor soils. Section III.2 discusses man in the period prior to arrival of the first Europeans in the region. It briefly presents the archeological record of Amerindians, their physical types, and discusses their successful adaptation to Amazonian environments.

Part II examines the Amazonian sociosystem and has been divided into two main chapters. The first, chapter IV, deals with the first centuries of the European man in the region up to the early 1960s. Section IV.1 discusses the arrival of the first Europeans in Amazonia including the discovery of the Amazon River, the role of myths in attracting explorers to the region, and the expulsion by the Portuguese of other European invaders in Amazonia. Section IV.2 examines Amazonian development during the colonial period concentrating on the problems of labor scarcity, the role of Indians during this period, and the conflicts between missionaries and colonists over Indian labor issues. It also includes discussions on the Portuguese westward territorial expansion, the forest-dominated economy of the period, the difficulties of agricultural activities, and the activities of Marquis of Pombal in Amazonia. Section IV.3 discusses the region's development during the Brazilian Empire and Old Republic periods. During these periods, a single forest product--rubber--dominated Amazonia's economy. This

section discusses the rise and fall of the rubber economy including a description of the rubber production and financing and marketing systems, the prosperity of the period, and the consequent terrritorial expansion and other consequences of the rubber economy. It also discusses the decline of the rubber economy and attempts to save it, and the failed agricultural colonization attempts in Amazonia during the period. The last section of chapter IV, section IV.4, deals with the period between the end of the rubber economy and the 1964 revolution. It discusses the brief revival of the rubber economy during World War II, and the new directions for the region designed by President Vargas and others during the period including the creation of SPVEA, Brasília, and the Belém-Brasília highway. It also discusses the Ford rubber plantations in Pará, the Japanese colonization, the International Institute of Hylean Amazon, and mining in the region.

Chapter V discusses the various developmental attempts promoted by the 5 governments since the 1964 revolution. The chapter is also divided into four sections. Section V.1 concentrates on the major institutional and policy changes introduced by the first revolutionary government. It starts by discussing the land statute and its consequence for forestry. It then discusses the new regional development approach known as Operation Amazonia including the new fiscal incentive policy, the creation of SUDAM--and its emphasis on cattle raising--and BASA, and the restructuring of the Manaus Free-trade Zone. The section also discusses other important institutional changes such as the New Forest Code, the creation of IBDF

and other legislation of importance to forestry. Section V.2 examines the small settlers official agricultural colonization scheme along the Transamazonica highway. It analyzes the reasons for the scheme, the new institutional arrangement devised to implement the approach, the scheme itself and its failure. Section V.3 concentrates on the policy shifts brought about by the Geisel administration including, the new emphasis on private agricultural colonization, POLAMAZONIA, as well as the changes in SUDAM's fiscal incentives. The section also includes discussions on the traditional log supply system of Amazonia, SUDAM's and IBDF's approach to improve forestry production in the region, and other attempts at the creation of forest policy for Amazonia. Last, this section presents the new emphasis on large mining operations, their relations with hydroelectricity, and of the latter with forests. The last section of part II, section V.4, examines the latest changes in Amazonia including the creation of the Greater Carajás Program, the establishment of a new land institutional arrangement, the increasing migration to Rondonia and POLONOROESTE, and discusses some of IBDF's actions.

Part III of the dissertation is divided into three chapters. The first, chapter VI, examines the role of the forest-based sector in the development process. It starts by discussing the concept of development as understood in this dissertation. Next, the various contributions that the sector can make in the development process are discussed. Finally, Chapter VI ends with an examination of the various forest-based technology alternatives available for the improvement of

the welfare of the members of the Brazilian society. Chapter VII discusses the need for improved institutional arrangements for the promotion of a greater role for the sector in Amazonia's development and provides an examination of some of the basic forest-based development issues in the region as identified in the first two parts of the dissertation. The selected issues include (1) deforestation, (2) preservation of samples of Amazonian ecosystems, (3) forest-based colonization alternatives to agriculture colonization, (4) the role of the sector in the acculturation process of Amerindians, and (5) forests and hydroelectricity production. Chapter VIII summurizes the study.

PART ONE

THE AMAZONIAN ECOSYSTEM

CHAPTER II

Abiotic Components of the Ecosystem

II.1 Natural History of Amazonia and its Current Geology and Geomorphology.

Amazonia, as part of the geo-biosphere, is intimately linked with the history of the earth and is the result of a long process of development. In order to understand the current ecological system existent in the region--its biogeography, biological diversity, pedology, geomorphology, geology--, it is necessary to go back in time and follow the relevant natural history of the world, South America, and Amazonia.

Table I presents the geological time scale combined with the description of some events which have affected various aspects of the Amazonian ecosystem development.

Already at the beginning of the geological times, the basic geological structure of the Amazon Region was being formed. Figure 5 shows various phases of this formation. In part one, it presents two--a northern and a southern--Archean islands formed during the Early Precambriam Time (Archean Era) and which later became, respectively, the Guianan Shield and the Brazilian Shield. This discussion, however, starts with the events occuring in the Phanerozoic Time--which starts with the Paleozoic Era--since up to that time most of the events in the

Table I : Geological Time Scale and Some Events Affecting the Development of the Amazon Ecosystem.

Era	Period	Epoch	Duration (Millions of years approx.)	Approx. Millions of years ago	Some Events
Archean			2100	4600	.Formation of the Earth's crust including the formation of the Northern and Southern Archean Islands of South America.
				3500-3000	.Early bacteria and algae.
Proterozoic			1930	2600-1500	.Buildup of free oxigen in atmosphere.
				1500-1000	.Formation of early supercontinent.
				800-400	.Breakup of early supercontinent and early multicelled organisms appear.
Paleozoic	Cambrian		70	570	.Early shelled organisms.
	Ordovician		70	500	.Early fish.
	Silurian		35	430	.Early land plants (vascular) in Late Silurian and also the beginning of the uplift of the Andean Region.
	Devonian		50	395	.In Late Devonian woody-tree-like plants up to 25 m high had evolved; no separated floral regions existed; Andean Region uplifted above sea level; in the Amazonian through 1500 feet of marine Devonian sandstone, shale, and limestone were laid down.

Table I : Geological Time Scale and Some Events Affecting the Development of the Amazon Ecosystem (cont.).

Era	Period	Epoch	Duration (Millions of years approx.)	Approx. Millions of years ago	Some Events
	Carboniferous		65	345	.Occurance of a great glaciation in Gondwanaland; early reptiles; by Late Carboniferous, five distinct floras had appeared; the Glossopteris flora in Gondwanaland was the most distinct of all five.
	Permian		55	280	.Final assembly of Pangaea.
Mesozoic	Triassic		35	225	.Permian and Triassic Pangaea appear to have had a fairly uniforme fauna--early land vertebrates (amphibians and reptiles); in Early Triassic Gondwanaland's Glossopteris flora was replaced by the seed-fern Dicroidium restricted to the region and also uniforme; Early mammals appear; in Late Triassic dinosaurs appeared and came to dominate the world throughout the Jurassic and Cretaceous; Pangaea starts to split.
	Jurassic		54	190	. Early birds appear.
	Cretaceous		71	136	.Split of Gondwanaland; in Mid-Cretaceous: (1) rise of the flowering plants, (2) placentals and marsupials appear, and (3) Africa and South America start separating; in Early Late Cretaceous the formation of the Andean Cordillera began and by Late Cretaceous the Andean geosyncline ended; during the Very Late Cretaceous contact between Northwestern North America and Northeastern Siberia occured; at the Very end of the period the dinosaurs became extinct.

Table 1 : Geological Time Scale and Some Events Affecting the Development of the Amazon Ecosystem (cont.).

Era	Period	Epoch	Duration (Millions of years approx.)	Approx. Millions of years ago	Some Events
Cenozoic	Triassic	Paleocene	11	65	.Angiosperm dominate the world and mammals start to dominate it.
		Eocene	16	54	.By Mid-Eocene the tropical forests were well developed and many of the present day families and genera of plants were present.
		Oligocene	12	38	.The last major uplift of the Andes occured during the Late Miocene to the Pliocene; emergence of the Amazonian lowlands and the eastward drainage pattern is established; South and North America became permanently connected.
		Miocene	19	26	
		Pliocene	4.5	7	
	Quartenary	Pleistocene	2.5	2.5	.The Andes reached approximately their present height at some time during this epoch; Quartenary glaciations occured in temperate regions and their associated cool-dry periods in Amazonia; man crossed to North America from Asia some 30,000 years ago; man reached South America some time between 12,000 and 40,000 years ago.
		Holocene (Recente)	approx. last 5000 years		

Source: Based on Cox & Moore, 1980; Guerra, 1959 cited by Pires & Prance, 1977; Haffer, 1981; Kummel, 1971; Meggers, 1979; Pielou, 1979; Prance, 1978; Prance, 1982a; Siever, 1983; Sombroek, 1966; Willey, 1971.

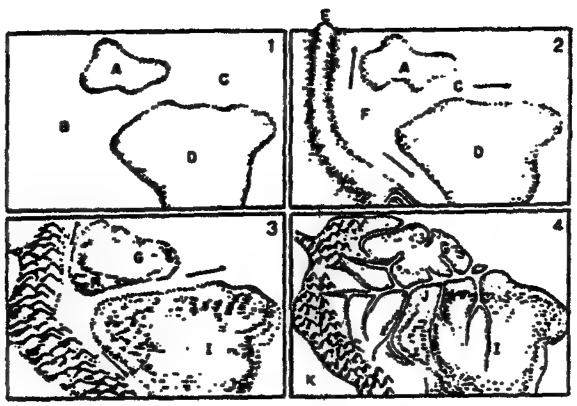


Figure 5 : The Formation of Amazonia: 1, Archean; 2, Early Tertiary; 3, Late Tertiary; 4, Quaternary. A, Northern Archean Island; B, Western Gulf; C, Eastern Gulf; D, Southern Archean Island; E, Early Tertiary Andean Arising; F, Inner Amazonian Sea; G, Guiana Plateau; H, Tertiary Sediments; I, Brazilian Plateau; J, Amazonian Plateau; K, Pacific Ocean (from Pires & Prance, 1977; after Guerra, 1959).

earth's history are common to all areas.

By the Late Silurian, the earth was inhabited by some early forms of bacteria, algae, shelled organisms, fish, and land plants (vascular). And by the Late Devonian, woody-tree-like plants up to 25m high had evolved (Cox & Moore, 1980:153; Siever, 1983: 48-9). Also by the Late Silurian, the uplift of the Andes Region started (Kummel, 1971:214). At this point of the Paleozoic Era, the early supercontinent--which had broken up during the Precambriam--was in the process of being reassembled to form Pangaea. (See figure 6.)

In the Late Devonian the evidence indicates that the floral composition of the earth was uniform (Cox & Moore, 1980: 153). In addition, during this period the Andean Region uplifted above sea level and "in the Amazonian trough 1500 feet of marine Devonian sandstone, shale, and limestone were laid down."(Kummel, 1971: 214)

During the Carboniferous a great glaciation occurred in Gondwanaland--the name of that part of Pangaea which corresponds to South America, South and Central Africa, Australia, Antartica and India--which at that time was around the South Pole. But this did not affect directly the Amazonian area (Cox & Moore, 1980: 144, 155). In the Late Carboniferous and Early Perminian, the isolation of the different continents, together with their differing climates, led to the appearance of five distinct floras. The Glossopteris flora, developed within the cool temperature parts of Gondwanaland, was the most distinct of all five (Cox & Moore, 1980: 144, 153-5).

It was during the Permian that the final assembly of all

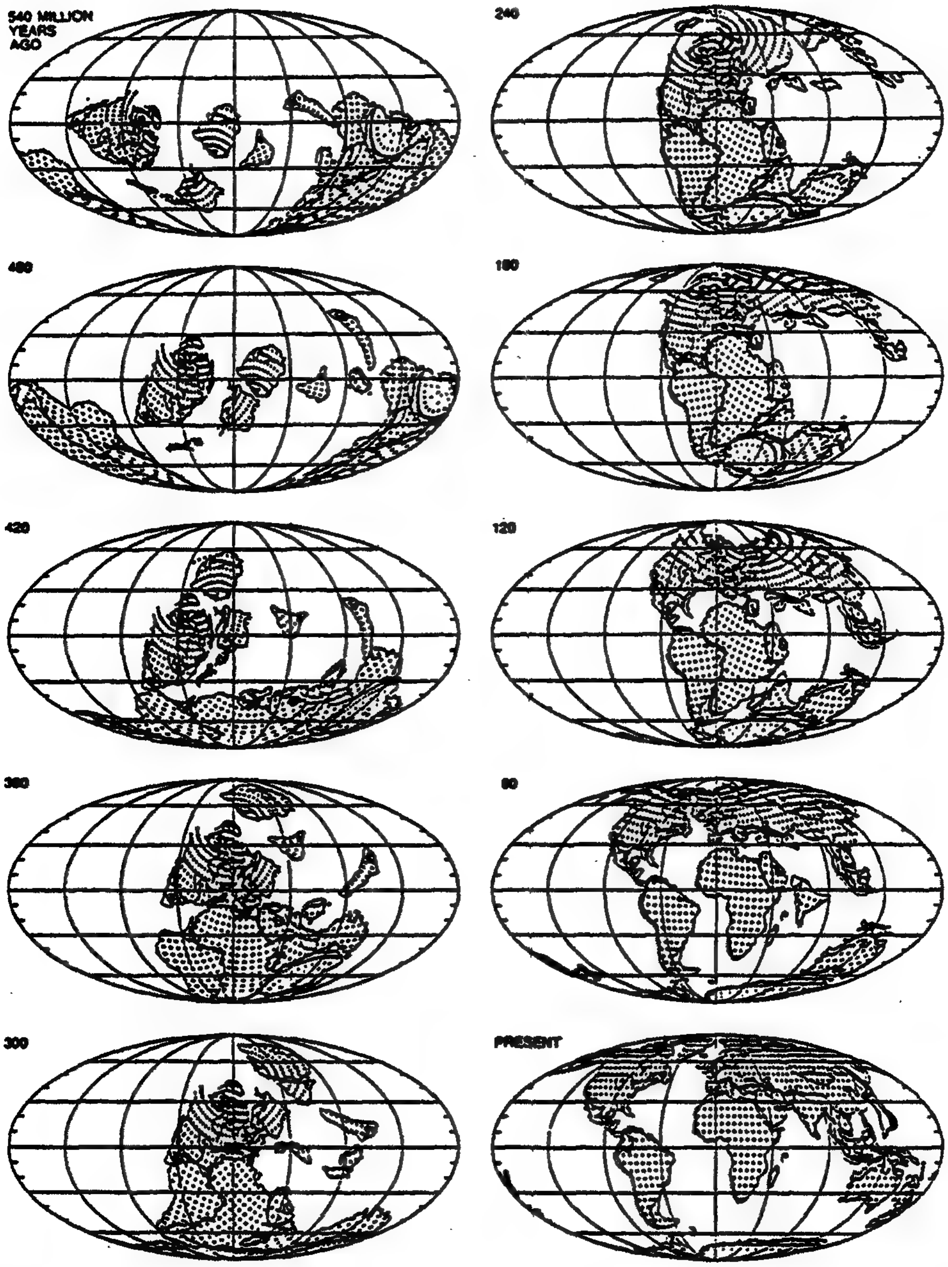


Figure 6 : Continental Drift Sequence Showing the Assembly and Breakup of the Supercontinent Pangaea (from Siever, 1983 after Ziegler & Scotese, n.d.).

continents to form once again one single supercontinent--Pangaea--is believed to have occured (Siever, 1983: 48). Pangaea was formed by two basic parts: (1) Gondwanaland in the south, and (2) Laurasia--formed by North America, Greenland and Eurasia--in the north (Cox & Moore, 1980: 144).

Paleozoic sediments were deposited along the course of the Amazon River between the Brazilian Shield and Guianan Shield (Kummel, 1971: 93).

In the Early Triassic Period of the next Era--the Mesozoic--, Gondwanaland's Glossopteris flora was replaced by the seed-fern Dicroidium which was also uniformly distributed into the continent and the region continued to be florally distinct into the Early Jurassic (Barnard, 1973 cited by Cox & Moore, 1980: 156).

The fauna of the whole Pangaea during the Permian and the Triassic appears to have been also fairly uniform. These early land vertebrate animals--amphibians and reptiles--"appear to have been quite competent at dispersing through regions of differing climate." (Cox & Moore, 1980: 156).

In the Late Triassic, dinosaurs appeared and came to dominate the world throughout the Jurassic and Cretaceous (Cox & Moore, 1980: 157). Early mammals also appeared in the Jurassic, but they did not become more varied until after the extinction of the dinosaurs at the very end of the Cretaceous (Pielou, 1979; Cox & Moore, 1980: 164). During the Mesozoic, intense orogenic and plutonic activities occurred in the Andean Region (Kummel, 1971: 214) and the sedimentation of the

Amazon Region continued. It was also during this Era that Pangaea started to split into fragments (Pielou, 1979: 28).

In the Late Jurassic, early flowering plants (angiosperms) appeared--some 20 million years before the early birds--and in the Middle Cretaceous they quickly spread throughout the planet (Pielou, 1979; Cox & Moore, 1980: 174). Also by the Middle Cretaceous, placental and marsupial animals appeared (Pielou, 1979). Cox & Moore (1980: 164) suggested that the marsupials have evolved somewhere in the South America-Antartica-Australia chain of continents. In addition, during this mid period Gondwanaland, between Africa and South America, started separating at latitude of South Brazil (Cox & Moore, 1980: 175). This separation, however, took a longer time because the costlines of Northern Brazil and Southwestern Africa were moving almost parallel with each other. Furthermore, the gap between them probably contained a number of islands along the crist of the mid-Atlantic ridge, therefore reducing it (Cox & Moore, 1980:175-6). The last land connection between these two continents was finally severed in the Late Cretaceous. "It is, therefore, not surprising to find that many families of tropical angiosperm appear to have dispersed between South America and Africa." (Cox & Moore, 1980: 176) For a comparison between the tropical forest ecosystems of Africa and South America see Meggers et al.(1973). The gradual separation of Gondwanaland into these two continents, Australia, and Antartica continued through the Cenozoic (Cox & Moore, 1980: 175).

In the Early Late Cretaceous, the formation of the Andean

Cordillera began and by the Late Cretaceous its geosyncline ended (Kummel, 1971). Contact between Northwestern North America and Northeastern Siberia was made by the Very Late Cretaceous (Pielou, 1978: 31).

It was during the current Era--Cenozoic--starting some 65 million years ago and during the Mesozoic that the Amazonian trough accumulated fairly thick sequences of sediments, much of which was of a non-marine--i.e., lacustrine and fluvial--origen (Kummel, 1971). In fact, the Terciary sediments are the most extensively observed in the region (Moreira, 1977).

At the beginning of the Cenozoic (Paleocene), mammals started to dominate the world which at that time was already covered predominantly by angiosperm plants (Cox & Moore, 1980: 160). Except in Australia and South America, competition from the more advanced placentals that evolved later in the Cenozoic led gradually to the complete extinction of the marsupials. In North America and Eurasia they did not survive beyond the Miocene (Cox & Moore, 1980: 166). It is because of the fact that the differentiation of the mammals occurred after the African and South American continents had split, that the mammal fauna of the two continents is substatially different (Cox & Moore, 1980: 164). For a comparison between the current mammal fauna of these two areas see Bourliere (1973).

By the mid-Eocene, tropical forests were well developed and contained many of the present day families and genera of plants currently in existence (Prance, 1982b: 4).

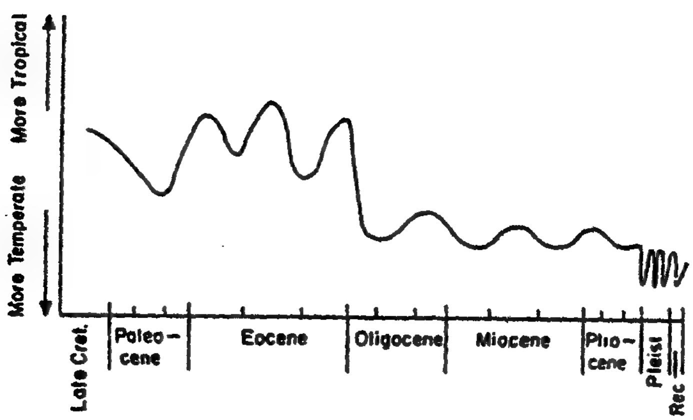
The last major uplift of the Andes occurred during the Late Miocene to the Pliocene. This uplift and its erosion combined with the consequent emergence of the upper Amazonian lowlands--at that time there was probably a vast lake or lakes and rivers covering the Amazon Valley and draining into the Pacific Ocean--led to the establishment of the eastward directed drainage pattern in the region during the Late Pliocene and Early Quaternary (Haffer, 1981: 374-5; Sioli, 1975b: 464; Rzoska, 1978: 39).

By the end of the Pliocene, South America became permanently connected with North America through the Panama Isthmus (Haffer, 1981: 373; Cox & Moore, 1980: 152, 166; Pielou, 1979: 31-5). This allowed the South American fauna and flora to colonize Central America up to the cool Mexican Plateau which divides the faunal regions of South and North America (Cox & Moore, 1980: 166). However, some of the southern animals reached further into North America, thereby enriching its poor diversity (Cox & Moore, 1980: 169).

The Andes mountains, although reaching their present height at some time during the Pleistocene, continued its vertical movements into the present as uplifted-river terraces, tilted or faulted gravel, heavy earthquakes and other evidences indicate (Kummel, 1971; Cox & Moore, 1980: 375).

During the Late Terciary and the Quaternary Period of the Cenozoic Era, climatic patterns of the earth varied much more frequently. (See figure 7.) The Plio-Pleistocene glaciation periods occurred in temperate

Figure 7 : The Changing Climate of the World During the Cenozoic, as Suggested by Floras from the Middle Latitudes.



Source: Cox & Moore (1980) after Wolfe (1978).

regions but their effects were not restricted to the ice-covered regions. The unglaciated areas also suffered the worldwide changes in atmospheric circulation caused by the presence of these ice sheets in high latitudes. Dry cool periods were experienced in Amazonia when glaciation occurred while the climate became warm and wet during the interglacial periods. These climatics variations, as discussed below, are hypothesized to be correlated with the large biological diversity observed in Amazonia and other tropical areas.

Sea level changes due to the Quartenary glaciation periods also occurred. At the high of the last glaciation (the Wisconsin-Wurm) about 20,000 years BP, sea level was 130 m below its current position--considered to be an interglacial period. In non-glacial epochs, when the world was practically free of ice, the sea rose to 70 m above its present level. The use of sea water to form the ice sheets was responsible for this 200 m sea level amplitude (Fairbridge, 1973 cited by Pielou, 1978: 111). These changes in sea level are supposed to have affected the Amazon Region in two basic ways: (1) during the glaciation periods the rivers draining the region ran in deeper valleys, and (2) during the non-glaciation periods, lakes were created (Lowe-McConnell, 1975: 73; see also Soares, 1977).

Man crossed to North America also in the Pleistocene from Africa via Asia--Siberia-Alaska connection--some time around 30,000 or more years ago (Meggers, 1979: v; Jennings, 1978: 1; Cox & Moore, 1980: 168). Stronger debate still exists among students of the matter about the time in which man arrived in South America from North America.

Estimations range from 40,000 to 12,000 years ago, although this last figure seems to be more likely (Meggers, 1979: 7; Willey, 1971: 9).

The millions of years of geologic history described above have determined the current geologic and geomorphologic features of Amazonia. These basic geologic and geomorphologic characteristics of the region are: the Guianan and Brazilian Shields to the north and south of the Amazon River, the Andean chain of mountains to the west, and the central lowland plains where the floodplains and its limiting *terra firme* are found. Figure 8 presents the basic geologic features of the northern part of South America.

The Guianan Archean crystalline shield of the Pre-Cambrian Era, stretches from west to east covering almost all the northern part of Brazil--except for the extreme east of Amapa. It correspond to the northern edge of the Amazon lowlands. In this shield, the highest point in Brazil is found--Pico da Neblina, with 3,014 m above sea level--located in the Imeri-Tapirapeco mountains in the most western of the shield's elevations (Moreira, 1977: 22). Figure 9 presents the relief of South America. Other mountains occurring in the area are the Paraima-Pacaraima and the most eastern one, the Tumucumaque-Acarai mountains located at the extreme north of the state of Para. These higher lands define the northern limits of the Amazon River Basin.

The Brazilian Archean crystalline shield, also from the Pre-Cambrian Era, is still not very well known (Moreira, 1977: 21). It forms the southern edge of the Amazon lowlands in a SW-NE direction and has a topography less accentuated than that of the Guianan shield.

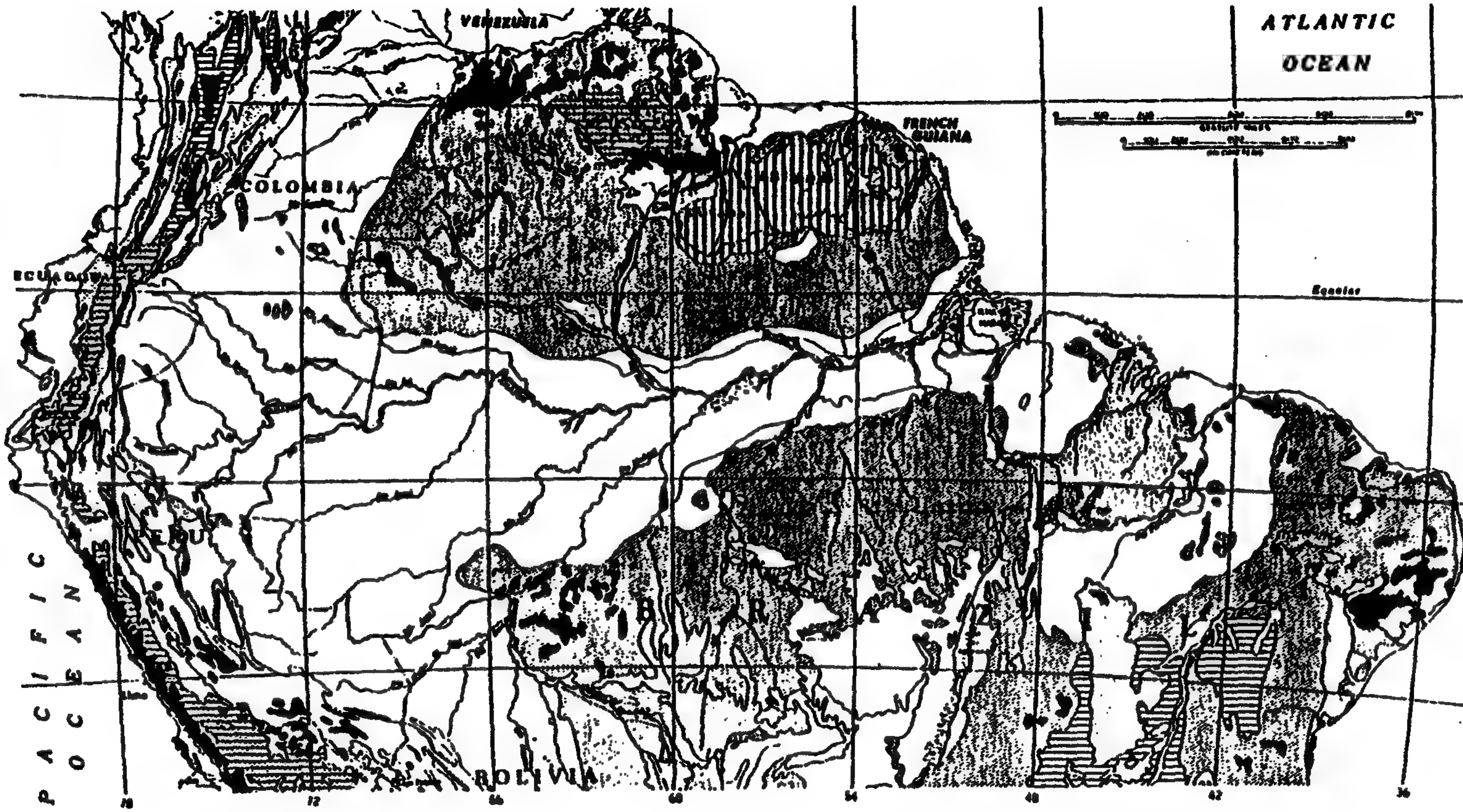
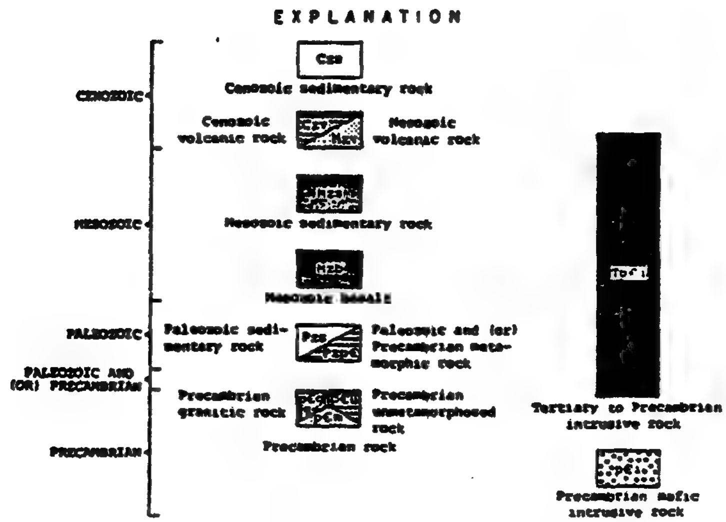


Figure 8 : Geologic Map of the Northern Half of South America.

Figure 8 : Geologic Map of the Northern Half of South America. (Continued)



Source: Modified from United States Geological Survey, 1977 after Comissão da Carta Geológica do Mundo, 1964 et al.

Figure 9: Relief of South America.

Source: After Prance & Pires (1977: 161).

Altitudes increase from the Amazon River to the south where the most significant mountains are found. The most noticeable of them are: the Caximbo mountains in the southwest of Mato Grosso, and the Parecis and Pacaas-Novos in Rondonia and western Mato Grosso.

The peripheric shields are extremely leveled with Tertiary sediments. Thus, the contact between the sediments and the shields is made basically without a topographic discontinuity except for some rapids along the middle Amazon affluents (Moreira, 1977: 21). Most minerals occuring in Amazonia are found in those two shields.

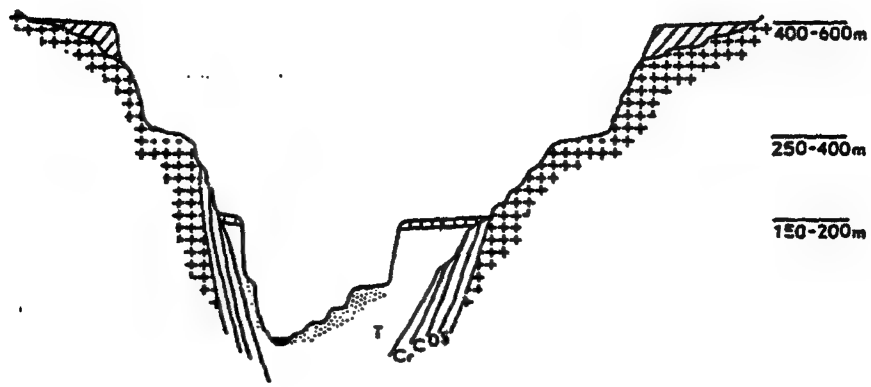
The lowland areas of Amazonia correspond to a large sedimentation basin on which the floodplains and the _terra firme_ are found. These lowlands--with altitudes generally inferior to 200 m--form a sort of funnel with its widest area found to the west facing the Andes and with its narrowest part reaching the Atlantic Ocean in the east. _Terra firme_ is the local name given to the higher grounds around the floodplains which are not reached by floods of the river. They are formed mostly by Tertiary and younger sediments and advance both to the north and to the south over the deeper Archean shields, gradually reaching higher altitudes.

Várzea is also a local name in this case given to the floodplains around the Amazon River and some affluents which carry a load of sediments from the Andean foothills. Due to the relationship of this element of Amazonian geomorphology with the nature of the rivers of the area, the discussion on _várzea_ will be made below where the Amazonian River Watershed is discussed. Here, however, it is

necessary to comment on the geology of the varzea area. Figure 10 shows examples of cross-sections of the Amazonia and of the principal depository basin indicating the various layers of sedimentary rocks which are found over the Pre-Cambrian rocks associated with the Brazilian and Guianan shields.

Figure 10 : (a) Schematic Cross-section of Amazonia (Sombroek, 1966).
(b) Schematic Cross-section of the Principal Sedimentary Basin of Amazonia (Adapted from Sombroek, 1966 after Petrobras, 1961).

(a)



C= Carboniferous; Cr= Cretaceous; D= Devonian; S= Silurian; T= Tertiary.

1. Outcropping crystalline shields; 2. Early Tertiary peneplanation surface on the crystalline shields; 3. Cretaceous peneplanation level and deposits; 4. Plio-Pleistocene Amazon planalto (broken hatching; subsided) with Belterra clay; 5. Pleistocene terraces; 6. Holocene sediments.

(b)

a. Pre-Cambrian; b. Pre-Silurian and Silurian; c. Devonian; d. Carboniferous; e. Juracic (diabase); f. Tertiary and Quaternary.

II.2 Climatic Aspects

The climate and hydrological characteristics of the Amazon Region are two of the most important ecological features of the area. Besides their importance for the sociosystem, they are intrinsically related with many other ecological features of the region--such as vegetation cover, soil formation, and rivers.

The North of Brazil is one of the country's geographical regions with the poorest network of metereological stations (Nimer, 1977: 39). This deficiency requires that climatologists make greater extrapolations about the features of the regions. Nevertheless, a general characterization of the area is possible.

In general terms, the region is characterized by high values of temperature, cloudiness, precipitation, and humidity, and by their relative uniformity throughout the region (Rastinoba, 1976: 260). These are also some of the basic features of a tropical rainforest climate (Rumney, 1968: 493). Other characteristics listed as typical for the area are the very low amplitude of the annual variation of vapour pressure--from 28 mbar in the summer to 26 mbar in the winter--and the fact that daily temperature variations are usually greater than the variation between the mean monthly maximum and minimum. In terms of precipitation, two basic seasons are frequently identified--one wet and other dry. The dry season can vary anywhere from five to zero months long, depending on the location within the basin.

The average long-term metereological condition of any region, or its climate, is a function of many factors. Koppen, according to Eidt (1969: 54), refers to external factors such as astronomical location, general circulation pattern, geomorphological features of the area, exposure and altitude as factors on which climates depend. Their influence are expressed by a group of climate elements which include: temperature, rainfall, atmospheric pressure, wind speed and direction, relative humidity and cloudiness.

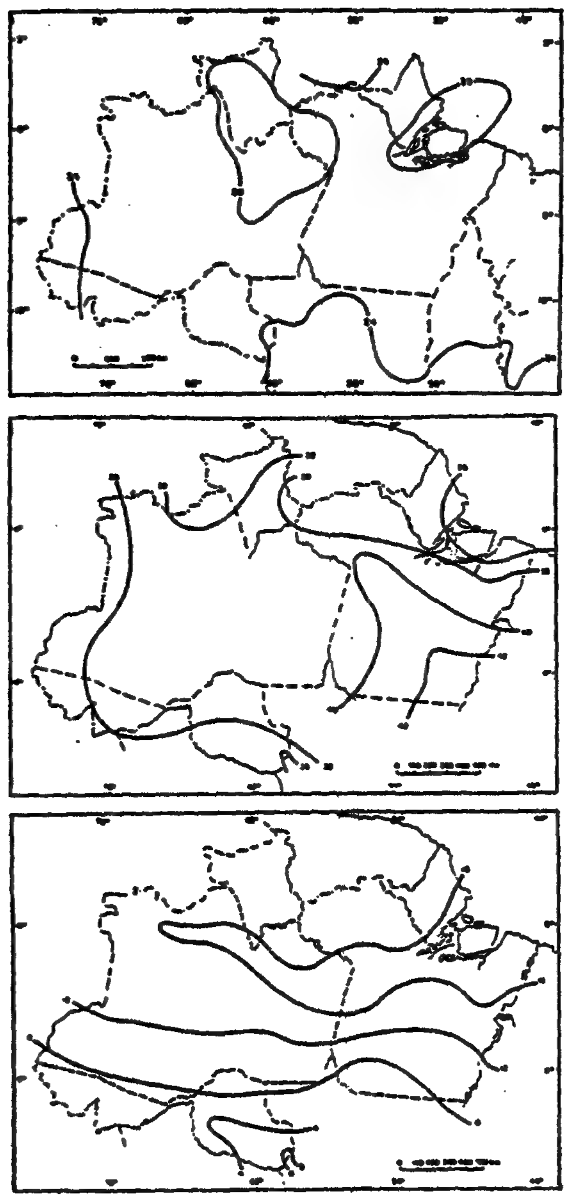
The classic Amazonia Region is located along the Equator between 73° 59' 32" and 46° 06' 30" of longitude west and between latitudes 5° 16' 19" North 'and 13° 41' 30" South, where a tropical-equatorial condition dominates. The importance of this location relates to the amount of solar radiation that approaches the region's surface. In addition, the meridional movement of the sun is the principal factor responsible for the weather patterns of the region (Salati et al., 1978: 204).

Another factor affecting the climate of the region is its geomorphological characteristics. The geomorphology of Amazonia,as discussed above, is dominated by four basic elements: (1) the Amazon lowlands, (2) the Guianan Highlands, (3) the Brazilian Highlands, and (4) the Andes mountains. The basic effects of the first three surface features on the climate can be briefly discribed as follows. The Guianan and Brazilian Highlands form a sort of corridor where the lowlands are located. Through this corridor the warm and humid winds from the Atlantic Ocean coast are "able to enter and to blow upriver

where they bring large quantities of moisture to the lowland" (Eidt, 1969: 59; see also Salati et al., 1978: 204). The effects of the presence of the Andes on the South American climate is twofold: (1) they prevent winds from the South Pacific anticyclone from entering the interior of the continent (or they reach it only after their moisture have been deposited on the mountains' slopes), and (2) they cause the moist east winds coming from the Amazon area to rise which brings about much heavier rainfall on the western part of Amazonia than found on its lower elevations (Eidt, 1969: 56).

It is typical for areas in equatorial zones to have the range in daily temperatures exceed the range of temperature means between the warmest and coolest months of the year. These "daily seasons"--as opposed to seasons occurring along the year--are usually more evident during the drier period of the year (Walter et al., 1975: 4-5; Rumney, 1968: 496). In general, the Amazon region follows this pattern. However, factors like the deep soils, vegetation cover, large river network, high percentage of cloudy days, and high humidity make the daily temperature range lower than observed in other equatorial regions (Nimer, 1977: 46).

As can be seen in figure !!, mean annual temperature is uniform throughout the region except for some lower temperature means in (1) the extreme west where a cold front reaches, (2) in the south where the Parecis mountains occur, and (3) on the north central area where some mountains of the Guianan highlands occurs. (See also figure .) However, as figure and show, daily temperatures can vary



(a)

(b)

(c)

Figure 11: Temperature (°C) in Amazonia—Isotherms: (a) Mean Annual; (b) Maximum Absolute Annual; (c) Minimum Absolute Annual (after Nimer, 1977).

substantially. Although the monthly highest averages occur during the months of September-October and November-December, the daily maxima generally do not occur during these months. This is the case because of the high relative humidity and cloudiness also observed during these periods. (The temperatures around 40 °C observed in the southeast part of the region are exceptions since they do occur during these months.) (Nimer, 1977: 42)

"The most important factor lowering the maxima in the Amazon Valley is the cloud cover and the fact that the greater part of the solar energy is consumed in evapotranspiration by the plant cover" (Ratisbona, 1976: 236).

The warmest months of the year are September and October--reaching averages of 26-28 °C--, and June-August are the months with the "coolest" averages--all superior to 22 °C (Nimer, 1977: 42, 44-5). However, during these cooler months temperatures may actually become very low. (See figure 12.) They are explained "by a phenomenon which can persist through several days, popularly known as friagem; it is a pronounced decreased of temperatures in the southern winter." (Ratisbona, 1976: 260) Friagens occur due to periodic invasions of the cold polar anticyclones which traverse South America following two trajectories, one continental reaching the Amazon Valley, and the other going over the Atlantic Ocean (Ratisbona, 1976: 225; See figure). These polar cold fronts invade the valley with winds from the south, provoking rains and followed by substantial drops in temperature (Nimer, 1977: 41). Although the passage of cold fronts

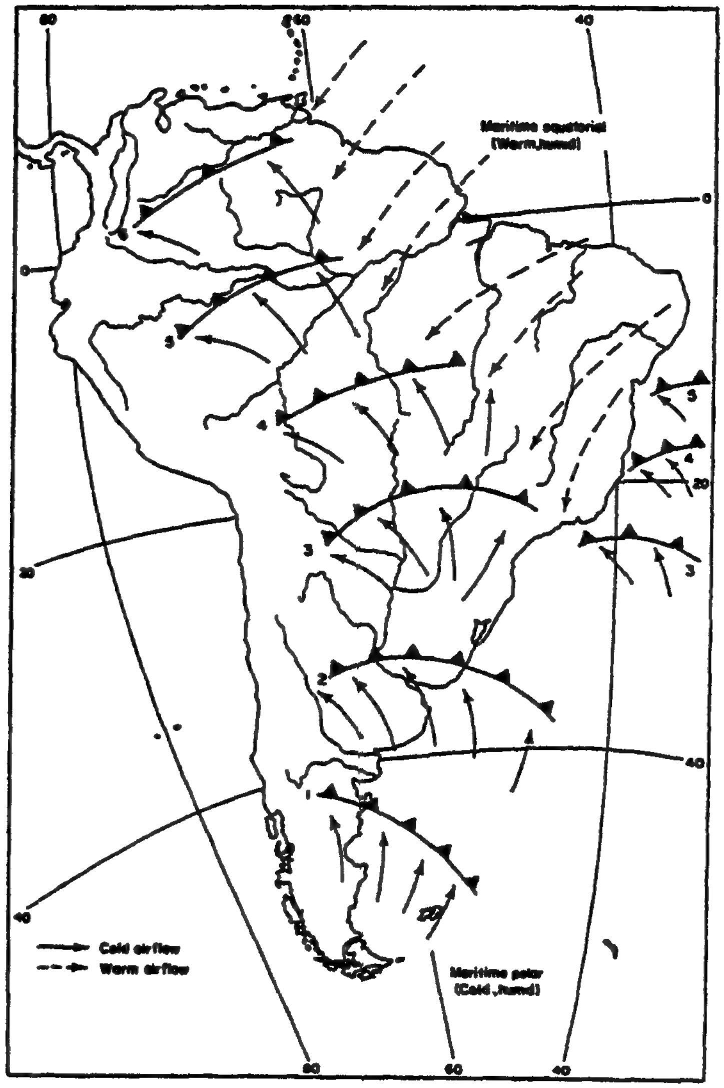


Figure 12: Northward Advance of a Cold Front Across South America on Six Successive Days, Crossing the Equator on the Sixth Day (6). Division of the Front Along the Brazilian Escarpament Begins on the Third Day (3) (after Rumney, 1968).

is a common event in the winter, the _friagem_ phenomenom is less frequent (Nimer, 1977: 45).

In general, the maximum cloud cover, atmospheric humidity, and precipitation occur during summer, the period of maximum potential sunshine (Rumney, 1968: 493). In Amazonia, most of the solar energy is used for evapotranspiration, "so that the land surface acts as a regulator of temperature and as a supplier of moisture." (Ratisbona, 1976: 221-2) In general, the region possesses a substantial cloud cover during the year as figure 13 shows. In fact, "the upper Amazon reveals the highest mean annual amount of clouds in ... (Brazil), where in the eastern part of the (Amazon) river's upper course it rises to over 8/10 of the sky covered." (Ratisbona, 1976: 230) This proportion also gives an indication of the insolation--duration of sunshine--that the area receives since both are complementary.

Another climatic feature of the region is the high amount of precipitation that it receives yearly. Ratisbona (1976, 248-9) has identified three basic types of rainfall regimes for Amazonia: (1) maritime equatorial, (2) continental equatorial, and (3) northern continental tropical. The first type is called maritime because these rains are produced by maritime air masses that penetrate into the continent. This type is observed on the mouth of the Amazon River and the Amapá Federal Territory area. A pattern of high precipitation in the fall and low in the spring is well defined for this type of rainfall. The continental equatorial type is characterized by evenly distributed precipitation throughout the year. "There is no real dry

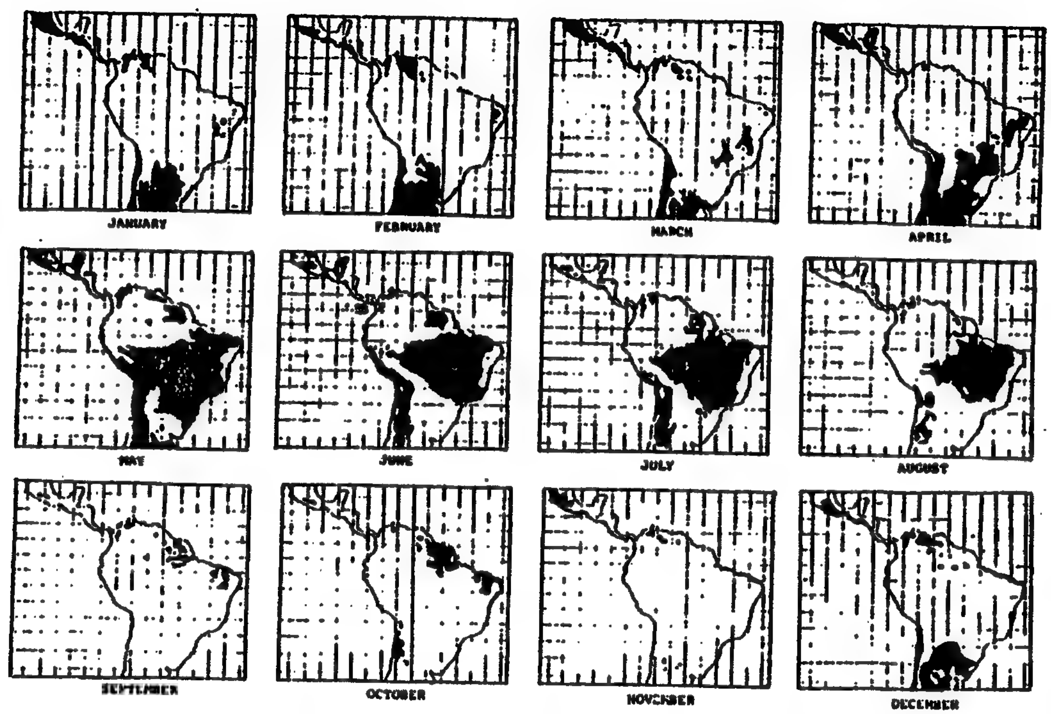


Figure 13: Monthly Importance of the Dry Season in Different Parts of the Neotropics, as Determined by Satellite Surveys. Black Areas Indicate Minimal Cloud Cover During the Entire Month, at 1400 Hours Local Time, Based on Albedo Levels--0-2 in a Scale of 0-8 (from Brown, 1983; after Miller & Feddes, 1971).

season: the heaviest rains occur at the end of the autumn and the beginning of the winter (May), and the lightest in spring. ... This type is related to the equatorial convergence." (Ratisbona, 1976: 249) Finally, the northern continental tropical, which corresponds to the tropical seasonal pattern observed in the *northern hemisphere* with maximum and minimum precipitation in the summer and winter, respectively. This type is observed in the continental parts of the Amazon region north of the Equador, where dry and rainy seasons are clearly defined. Heaviest rains occur in July and the lightest in February, corresponding to the high and low positions of the sun over the hemisphere.

Figure 14 presents the annual total rainfall isohyets. Unlike the distribution of temperature over the region, precipitation totals are not so uniformly spread. Greater precipitation occurs in the northwest, where it reaches up to 3,500 mm per year, on the mouth of the Amazon River and Amapá coast, and on south central Amazonia. Rainfall distribution along the year also varies spatially, not only in terms of the rainfall difference between the wettest and drier months, but also in terms of when the wettest months occur. The largest pluviometric amplitude observed in the region is between 300-500 mm at the mouth of the Amazon River and Amapá coast. The southern parts of Pará and Amazonas, and the northern part of Rondonia also have large amplitudes reaching 350 mm. The least variation between the wettest and drier months is observed at the northwest part of the state of Amazonas. Pluviometric amplitude for most of the rest of the region varies

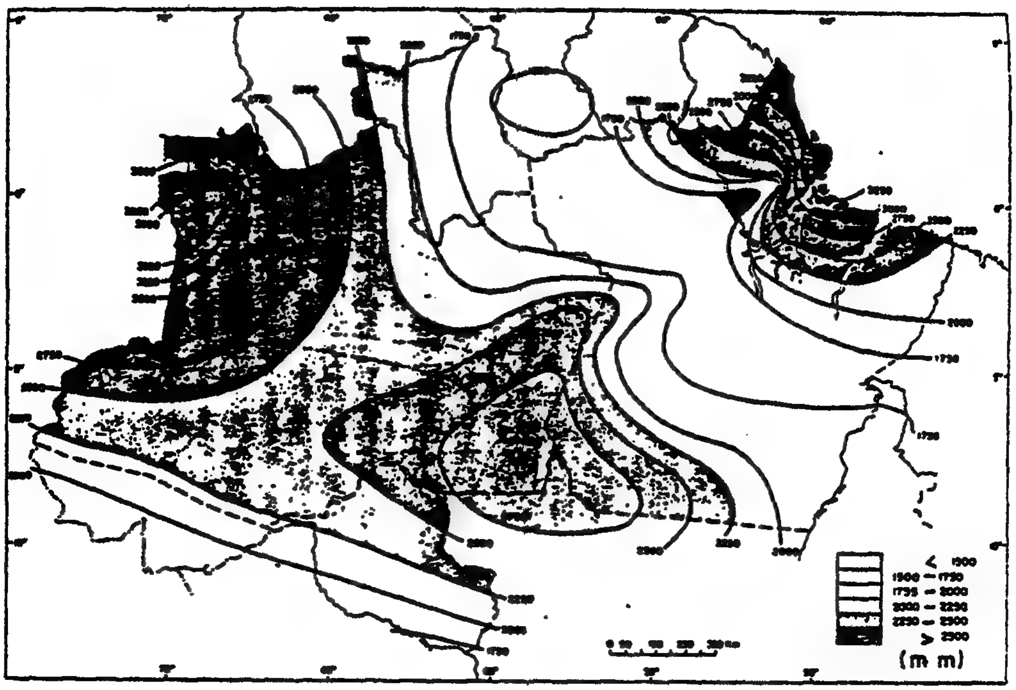


Figure 14 : Annual Mean Rainfall—Isohyetas (Adapted from Nimer, 1977).

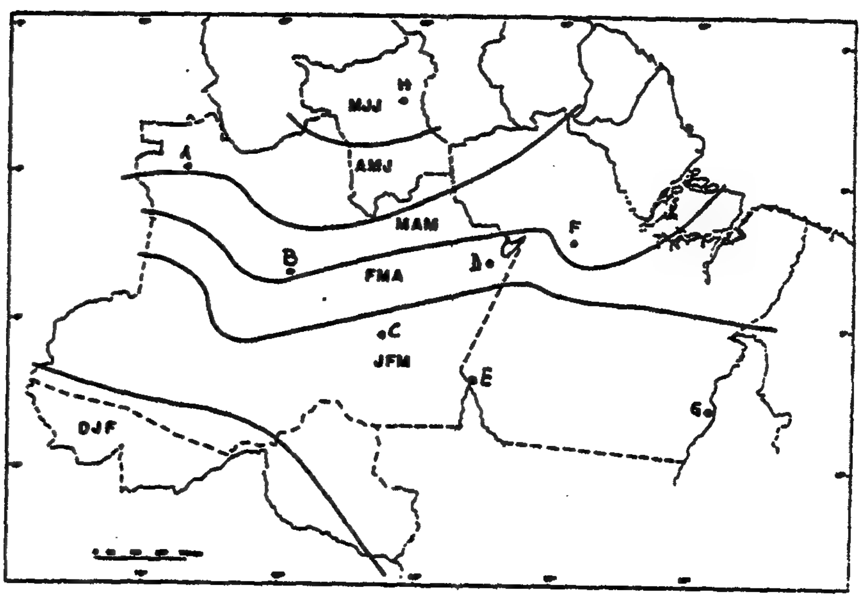


Figure 15 : Three Month Periods of Maximum Rainfall (adapted from Nimer, 1977).

between 250 and 350 mm (Nimer, 1977: 48-9).

The occurrence of the months with most rainfall follows the pattern of the hemisphere summer. (See figure 15.) Thus, south of the Equator the months between December and April usually include the highest amounts of precipitation. North of the Equator, most of the rains occur between March and September (Nimer, 1977: 49-51; Rumney, 1968: 493). This rainfall distribution pattern has its effects on the regime of the rivers of the region, as mentioned above.

The dry season in Amazonia can last anywhere from zero months (on the Northwest part of Amazonas state) to four or five months (on the East part of Roraima Federal Territory). Except for this last area, the dry season in the region is usually not totally absent of rainfall. However, these occasional rains are not sufficient to affect the general pattern of the dry season substantially (Nimer, 1977: 51).

Variation of the annual total rainfall from year to year in the region also occurs. Rainfall can vary from the "normal" amount plus or minus 10 percent, as observed in the upper Rio Negro and the mouth of the Amazon River, to plus or minus 25 percent in other areas. However, the average variation of the total rainfall from year to year is more than 15 percent (Nimer, 1977: 51; Ratisbona, 1975: 251-2). Nimer (1977: 51) suggests that the temporal variation is due to "regional atmospheric mechanisms". In some years, Nimer (1977) reports that certain locations have received almost twice as much as rainfall they receive during normal rainfall periods.

High rainfall intensities characterize the rainfall pattern of

the Amazon basin. The highest rainfall intensities in the lower Amazon region vary between 100-150 mm/24 hours, though at some points on the coast it has reached 250 mm/24 hours. Over the upper Amazon and Rio Negro areas it is under 160 mm/24 hours and most of the meteorological stations in this area register intensities less than 100 mm/24 hours (Ratisbona, 1975: 248). Other features of the rainfall pattern besides intensity, such as duration and frequency—which are important in watershed management and other sociosystem activities (Jackson, 1977)—have not been found.

One of the important climate features of Amazonia is its high relative humidity. It has been estimated that around 56 percent of the precipitation falling in the Amazon River watershed returns to the atmosphere through the evapotranspiration process, while the balance is discharged into the rivers (Salati et al., 1978: 202; see also Kovzel, 1978: 390; Villa Nova et al., 1976; Jordan & Heuveldop, 1981; and Leopoldo et al., 1982). Considerable solar energy is consumed by evapotranspiration which reaches values "from 1,000 and 1,500 mm, thus being higher than the evapotranspiration obtained from oceans, which is less than 1,000 mm/year." (Ratisbona, 1976: 226, 243; see also Zubenok, 1978: 370-4; Villa Nova et al., 1976). Humidity and cloudiness are usually highest during the wet season (Rumney, 1968: 493).

During April, the wettest month of the mid-Amazon region, the humidity averages 85 percent while in August, the driest month, it is 75 percent. The annual humidity varies only 10-15 percent over the lower Amazon. During the rainy season relative humidity exceeds 90 percent,

while in spring it generally remains below 80 percent (Ratisbona, 1976: 244). In parts of the Amazon region, relative humidity can fall to 60 percent in the dry season (Rumney, 1968: 493). Figure 16 provides an illustration of the geographic distribution of the total wet season evapotranspiration (WSPE) regimes of the Amazon basin as proposed by Cochrane & Sanchez (1982: 145).

The equatorial continental mass of air is formed over the areas of dense forest in the Amazon basin, where calm air and weak winds prevail. Due to the evapotranspiration rate observed in the area, as noted above, this air mass is humid and convectively unstable. Relative humidity over the upper Amazon and Rio Negro, where rains are more or less constant during the year, varies little, remaining between 85 and 90 percent (Ratisbona, 1976: 244). According to Ratisbona (1976: 266), part of the rainfall of this area comes from local evaporation[1]. Three different sources agree with this assertion, although they seem to disagree about its relative importance. Kovzel (1978: 490) states that 23 percent of the total amount of precipitation falling on the Amazon basin is "formed by evaporation ...—that is to say, on account of local moisture circulation." Drozdov and collaborators (1978: 98) believe it to be a little more when they write that "for the basin of the Amazon River the atmospheric discharge, conditioned by evapotranspiration from the land, is equivalent to 35%. The remaining part of the removal of moisture is advective tranfer in transit." Salati and collaborators (1978: 205), however, concluded that "there is a water vapor recycling in the (Amazon) region, ...

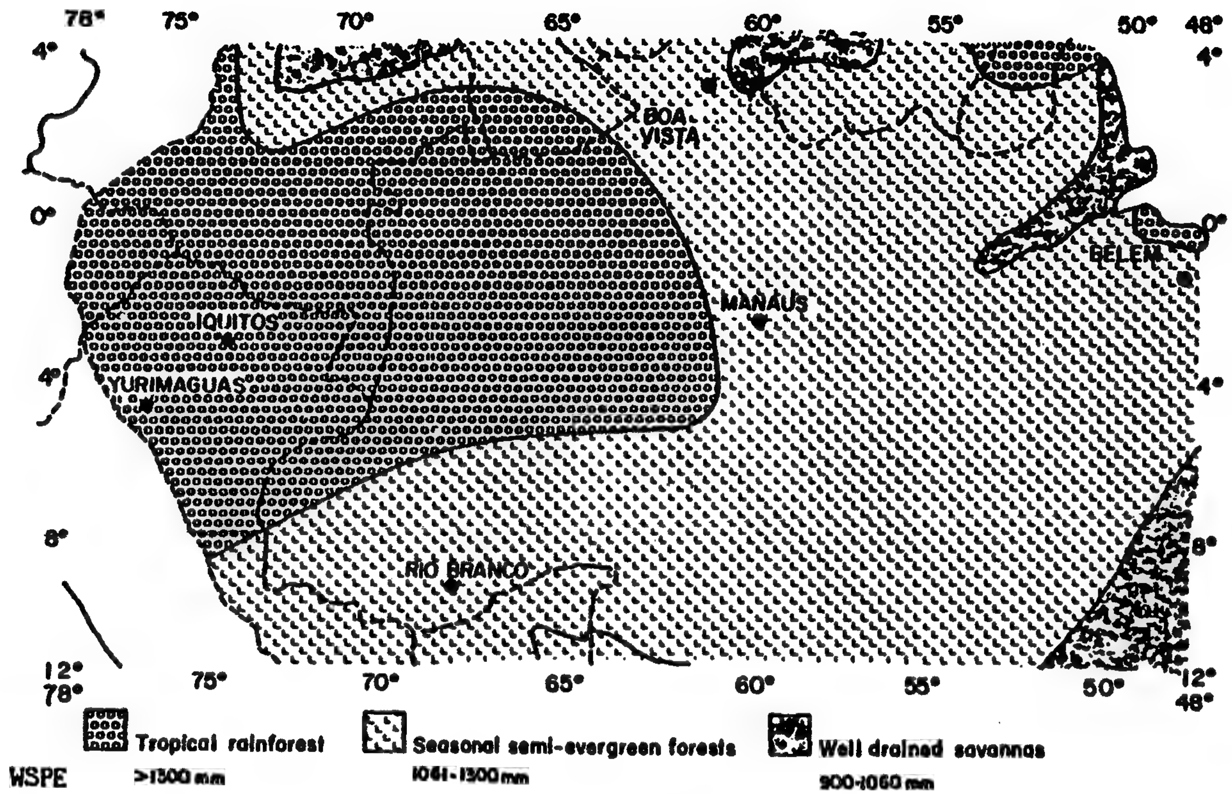


Figure 16 : Total Wet Season Potential Evapotranspiration (WSPE) Regimes of the Amazon Basin.

Source: Nicholaides et al. (1983) adapted from Cochrane & Sanchez (1982).

(where) probably 50% of the precipitation are due to this mechanism."[2] This 50 percent figure is an average over large areas which includes nonforested portions and water vapour exports. Newer evidence seem to be accumulating to support Salati's group as shown by the works of Jordan & Heuveldop (1981) and Leopoldo et al. (1982). These and other studies have indicated that evapotranspiration in smaller watersheds with high forest vegetation sends back into the atmosphere as much as 80.7 percent of the rainfall they receive (Salati & Vose, 1984: 130).

But the behavior of the air masses vary along the year:

> In the winter, (the equatorial continental mass) ... covers only the upper Amazon because the rest of the basin is dominated by the less humid mT (tropical maritime) air mass. In summer, however, with the recession of the anticyclone to the ocean and the formation of the continental heat low, the latter draws in the air from the Amazon region which dominates the whole interior of ... (Brazil), even in the south. (Ratisbona, 1976: 226)

It is likely that the water vapour collected in the region affects the weather of not only parts of Southern Brazil but also of other countries in the central-east part of South America (Salati & Ribeiro, 1979: 18).

To conclude this section, the general climate classification of Amazonia according to five sources is presented. First, the best known and most widely used Koppen classification is presented (UNESCO/UNEP/FAO, 1978: 37). This system establishes a broad classification based on numerical values of temperature and rainfall,

and associates them with five major vegetation groups (Rumney, 1968: 103-4; Eidt, 1968: 64). Figure 17a shows the map resulting from the application of this system to the region. In this case only category A--tropical forest climate, in which average monthly temperatures are all above 18 °C--is found.

The second example is provided by Rumney, who used the same basic principle used by Koppen to formulate his classification. That is, "that the presence and form of natural vegetation are mainly attributable to the qualities of the atmosphere." (Rumney, 1968: 106-7) The Amazon climate according to this system is shown in figure 17b. The next system is the one proposed by Walter and collaborators who base their classification on climate-diagram maps that they have developed and do not rely as heavily on vegetation maps to define broad climatic types (Walter et al., 1975). Figure 17c, shows the application of this system to the Amazon region.

The fourth system is provided by Cochrane & Sanchez (1982) and is based not only on the vegetation distribution of the region, but also on various other climatic elements, in particular, on data about wet season mean temperature (WSMT) and total wet season evapotranspiration (WSPE). Figure 16 above gives an approximation to the geographic distribution of the three basic climatic subregions of Amazonia according to these authors. Subregion A--Tropical Rainforest--correspond to the area with WSPE greater than 1300 mm and besides this, it is characterized by a wet season of nine or more months. Subregion B--Seasonal Semi-evergreen Forest--corresponds to the

(a)

(b)

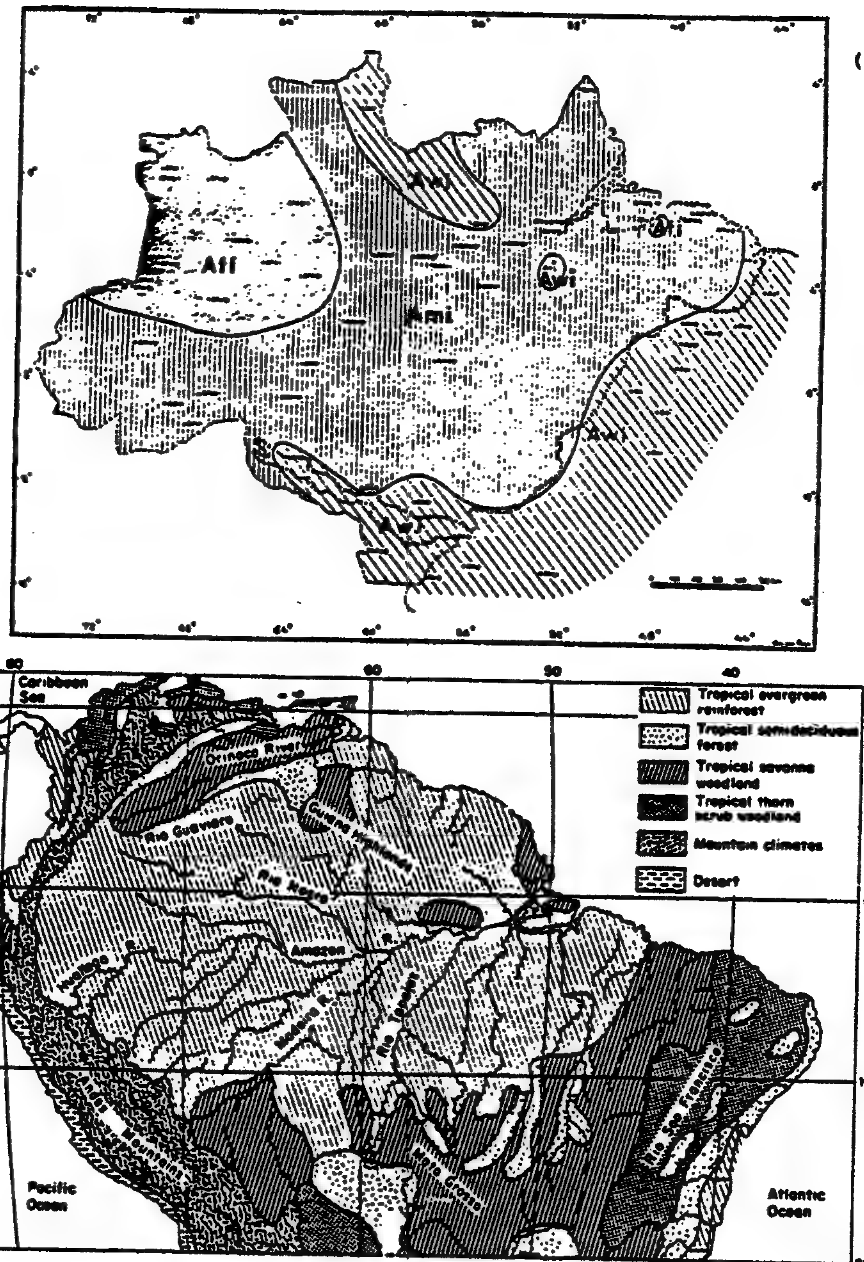


Figure 17: Climate Types of Amazonia. (a) According to the Koppen Classification (from Sioli, 1968; after Galvão, 1959). Af = Ever-Humid or Permanently Wet Tropical Rain Forest Variety, all Months Have Sufficient Precipitation; Am = Seasonally Humid or Subhumid, Evergreen Rain Forest with Month with Arid Characteristics; Aw = Savanna or Winter-dry Season Type. (b) According to Rumney (adapted from Rumney, 1968).

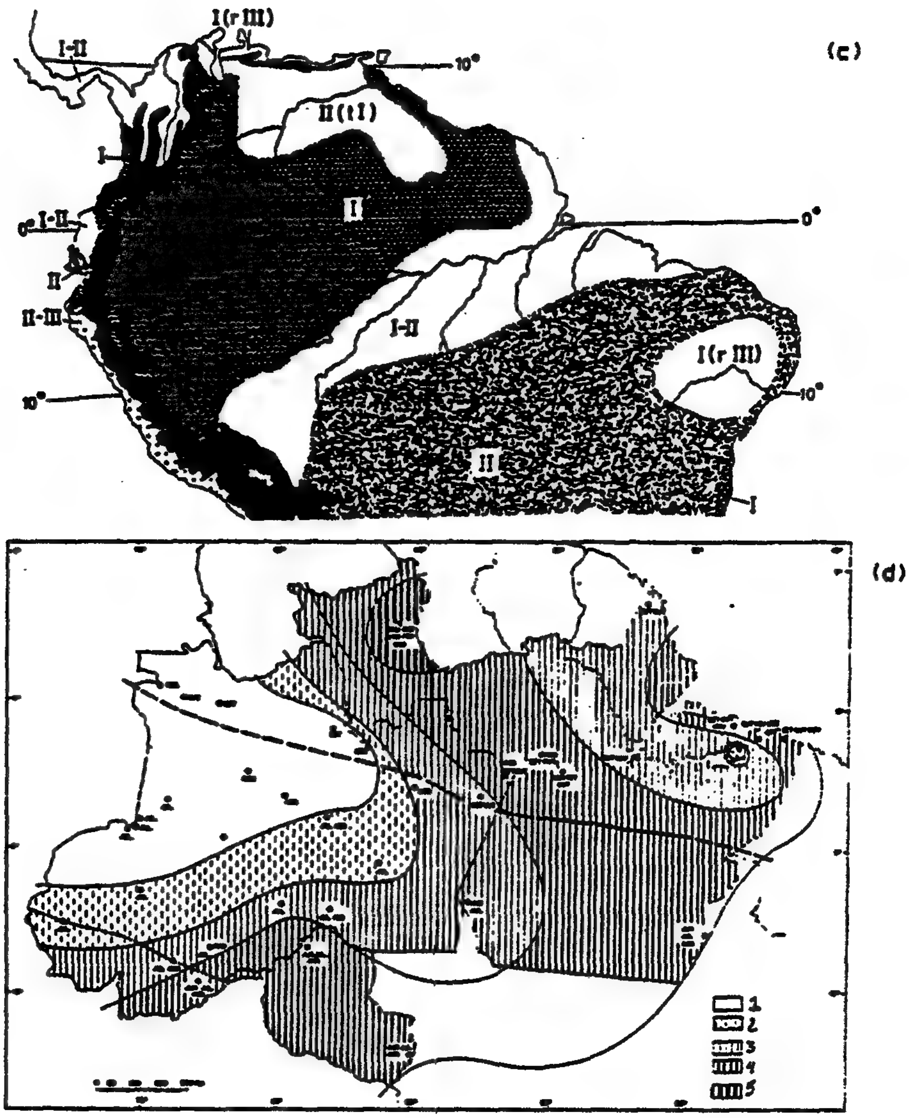
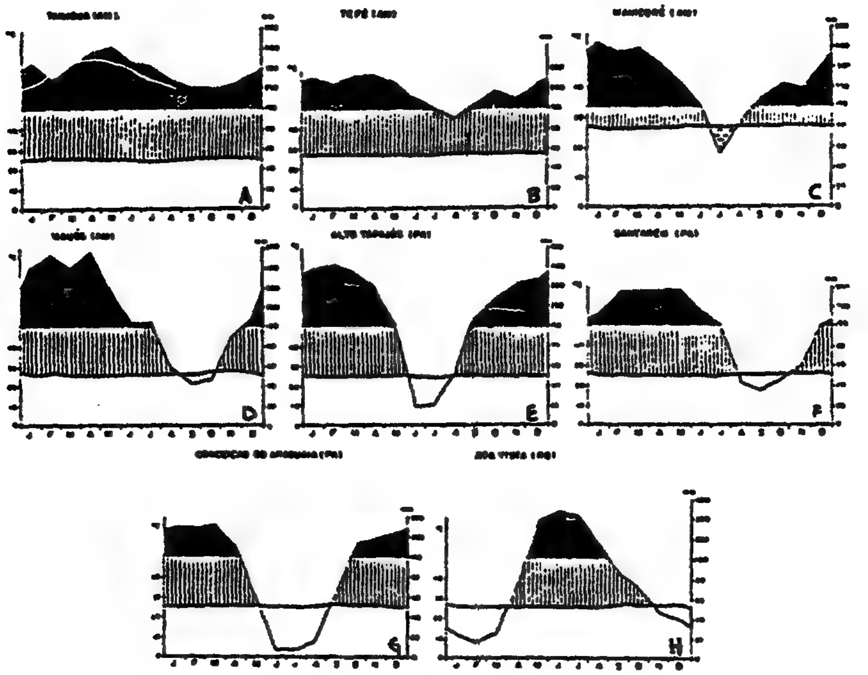


Figure 17: Climate Types of Amazonia. (continued) (c) According to Walter's Ecological Classification of Climates (adapted from Walter et al., 1975). I = Equatorial With Diurnal Climate; I(rIII) = Equatorial Desert; II = Tropical With Summer Rains; II(tI) = Daily Variation in Temperature is Greater than the Annual Variation. (d) According to Nimer (adapted from Nimer, 1977). All Types but (5) are Warm Equatorial Climates. (1) Super Humid Without Dry Season; (2) Super Humid With Subdry Season; (3) Humid With 1 to 2 Dry Months; (4) Humid With 3 Dry Months; (5) Warm Tropical Semi-humid With 4 to 5 Dry Months.

area with WSPE varying from 1,061 to 1,300 mm and is characterized by a wet season from 8 to 9 months. The last, subregion C--Savannas (isohyperthermic)--corresponds to the area in figure 16 with WSPE from 900 to 1,060 mm and has a wet season of 6 and 8 months. All three types have a WSMT greater than 23.5 °C (Cochrane & Sanchez, 1982: 138-148).

Last, a more specific classification system for the region developed by Edmon Nimer is presented. This system is based on several aspects of the regional temperature and precipitation patterns. These aspects include: the compensated mean of the coldest month, existence and duration of dry periods, seasonal precipitation movements, and atmospheric circulation systems (Nimer, 1977: 53-5). Figure 17d shows the Nimer's climate map for the region. This map is specially appropriate to show the areas with different patterns of precipitation distribution. This same feature and others can also be examined in figure 18, which presents information for selected metereological stations in the region. Specially noteworthy is the Northern and Southern seasonal contrast--dry and wet--which is clearly shown by a comparance between the graphics for Conceição do Araguaia (Pará) in the south and Boa Vista (Rondonia) in the north of the Equator.

Figure 18 : Climatic Information for Selected Metereological Stations in Amazonia.



— Mean Monthly Temperature Curve (°C)
— Total Monthly Rainfall Curve (mm)
Wet Pediod - Rainfall > 100 mm
Wet Period - <100 mm
Dry Period
Subdry Period

Figure 18: Climatic Information for Selected Metereological Stations in Amazonia. (cont.)

Meteorological Station *	Station Altitude (m)	Climate	Absolute Min - Max (°C)	Annual Mean (°C)	Mean of the Coldest Month (°C)	Annual Average Rainfall (mm)
A-Taraqua	105	a	10.6-38.9	24.9	23.9	3,496.6
B-Tefé	53	b	14.2-38.1	27.1	26.8	2,259.9
C-Manicore	80	c	10.4-39.0	26.5	25.9	2,868.1
D-Maues	34	d	12.2-39.0	26.4	25.3	2,630.3
E-Alto Tapajós	99	e	8.8-37.8	24.9	24.0	2,738.7
F-Santarém	21	f	22.6-31.0	25.8	25.1	1,973.3
G-Conc.Araguaia	151	g	11.7-39.8	25.5	24.9	1,670.4
H-Boa Vista	99	h	n.a.	26.5	26.0	1,504.4

* for location see figure 15.

Climate Types:

a- Warm and Superhumid; Equatorial-with no Drought and Rainfall Minimum in the Spring.
b- Warm and Superhumid; Equatorial-with no Drought and Rainfall Minimum in the Winter.
c- Warm and Superhumid; Equatorial-with Subdrought in the Winter.
d- Warm and Humid; Tropical-with 2 Months of Drought in the Spring.
e- Warm and Humid; Tropical-with 2 Months of Drought in the Winter.
f- Warm and Humid; Tropical-with 3 Months of Drought in the Spring.
g- Warm and Humid; Tropical-with 3 Months of Drought in the Winter.
h- Warm and Semihumid; Equatorial-with 5 Months of Drought in the Boreal Winter.

Adapted from Nimer, 1977.

II.3 The Amazon River Watershed

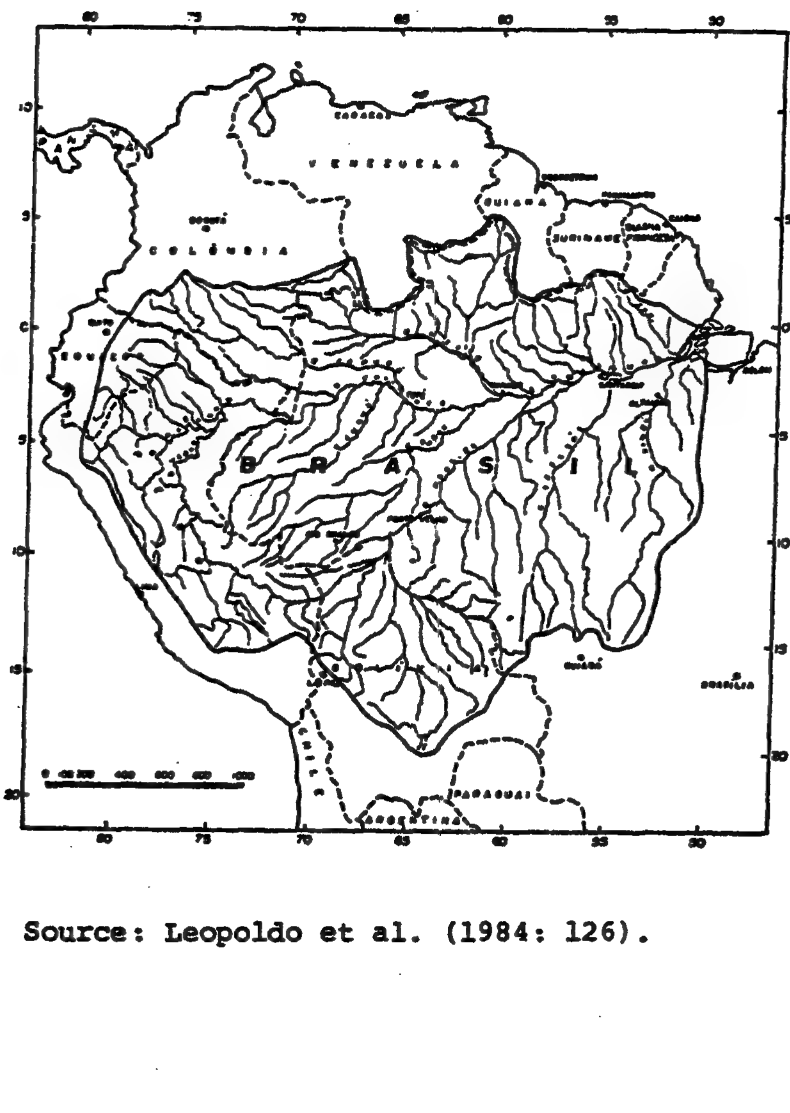
One of the consequences of the large amount of precipitation described above as falling in the Amazon region is a large drainage system that takes care of the excess of water that is not evapotranspired or that becomes ground water. In this section, some facts about this component of the abiotic ecosystem as it has existed in recent past will be provided.

The area of the Amazon River watershed is about 6,915,000 km^2—more than a third of the South American continent. It is the largest river basin on earth. The second largest,the Congo basin, has a watershed area a little over half the size of the Amazon's (Kopylov et al., 1978: 31-3; Rzoska, 1978: 39; Kovzel, 1978: 390). (See table 2 and figure 19.)

Table 2: Basin Area and Length of the Largest Rivers on Earth. (Adapted from Kopylov et al., 1978: 31-33.)

River	Area of the Basin (10^3 km^2)	Length (km)
Amazon (with Ucayali)	6,915	6,280
Mississipi	3,220	5,985
Congo	3,820	4,370
Nile (with Kagera)	2,870	6,670
Ob (with Irtysh)	2,990	3,650
Volga	1,360	3,350

Figure 19: Amazon River Watershed.



Source: Leopoldo et al. (1984: 126).

Over this immense area a large quantity of rain falls every year amounting to an equivalent of 14,900 km^3 of water—more than half (52 percent) of the total volume for the entire South America Region (Kovzel, 1978: 390). Some of this water, as discussed, returns to the atmosphere in the form of vapour, and according to Kovzel (1978: 39) some 6,930 km^3 (46.5 percent) flow into the Atlantic Ocean. Between the time when the water falls in the region and the time that it is either evapotranspirated or discharged into the ocean, the area has to deal with a very large quantity of water. This fact combined with other features of the climate as well as the relief and geological formation of the region—which define the dimensions of the watershed—led to the formation of the most dense drainage network on earth (Kopylov, et al., 1978: 30; Sioli, 1975b: 461; Rzoska, 1978: 8). This network is composed of many rivers, streams, creeks, swampy and floatable areas, lakes and lake-like mouthbays of affluents, and lagoons in floodplains (Sioli, 1975b: 463).

The Amazon River—which in Brazil changes its name to Solimões above Manaus and in Peru to Maranon, Ucuyali, and Urubamba or Apurimac—is the main water body of the watershed. This river has its origin in the Andean Cordillera and travels first in the south-north direction up to Equitos, Peru, and from there it changes to a west-east direction to reach the Atlantic Ocean.

The origin of the Amazon River has been the subject of discussion, not because the headwaters of the rivers cannot be found, but rather because there is not a consensus on which rivers are its

most important contributers. The proposal which suggests that the headwaters of the Marañon River is the same as that of the Amazon seems not to be generally accepted. There seems to be a certain agreement, on the other hand, that the Ucuyali River in Peru is more important. The problem is that this river is formed by two others--Urubamba and Apurimac--but the total length of the Amazon River would not differ very much whichever is chosen--6,577 km and 6,571 km, respectively (Magalhães Filho, 1960 and Grande, 1955 cited by Soares, 1977: 120). Other estimates for the total length of the Amazon River are given by Rzoska (1978: 39)--6,670 km--and, as table indicates, by Kopylov and Collaborators (1978: 31-3)--6,280 km. It seems that Rzoska's figure is a little off target since most references indicate the African river Nile--6,670 km with Kagera River--as the longest river on earth followed by the Amazon as the second longest.

The Amazon River discharge corresponds to more than 15 percent of all the fresh water runoff entering the oceans (Alyushiskaya, 1978: 492-3). Every year 19,800 km^3 of fresh water is discharged into the Atlantic Ocean from all sources. Of this total, South America contributes 11,700 km^3 of which the Amazon River is responsible for almost 60 percent, i.e., some 6,930 Km^3 per year or approximately 220,000 m^3 per second. This corresponds to 35 percent of all fresh water river runoff going into the Atlantic Ocean. This volume of water is from 8-12 times larger than that of the Mississipi and it is as large as the combined discharge of all other great rivers going into the Atlantic Ocean (Rzosca, 1978: 7-8, 39).

The Amazon River Basin is essentially a large plain. "Although most of the river arise on higher grounds, yet only one/seventh of the whole river system is more than 200 meters above the sea level." (Rzosca, 1978: 39) Three fourths of the Amazon River itself are on lowlands. (See figure 20.) Where the Amazon River enters Brazil, some 3,000 km from the ocean, it is only 60 m above the sea. Thus, the river falls an average of only 20 mm/km (Soares, 1977: 120) and over the last 1,500 km, only 15 mm/km (Sioli, 1975b: 462). However, because of the large discharge of the river, streamflow velocities average from 0.5-1.0 m/second and 1.0-2.0 m/second in the dry and rainy seasons, respectively. In some narrow stretches of the Solimões and above the city of Óbidos in the middle Amazon, streamflow velocity can equal 3.0-4.0 m/second (Sioli, 1975b: 462; Soares, 1977: 120).

The Amazon River is extremely wide and deep over long distances. Where the Marañon River enters Brazil and becomes Rio Solimões, its width is already 1,000 m. In its lower section, the average width is about 5 km although in some parts it may reach 10 km. During periods of flooding, the river width can reach 50 km (Sioli, 1975b: 462; Soares, 1977: 120). The depth of the river over the lower basin averages between 20-50 m, but can reach as much as 118 m. These depths are sufficient to allow ocean-going ships to reach 3,700 km inland up to Equitos in Peru (Goodland & Irving, 1975: 1; Sioli, 1975b: 462; Soares, 1977: 123).

Other waterbodies of the basin are also of significant dimensions. Twenty tributaries to the Amazon River for instance, are

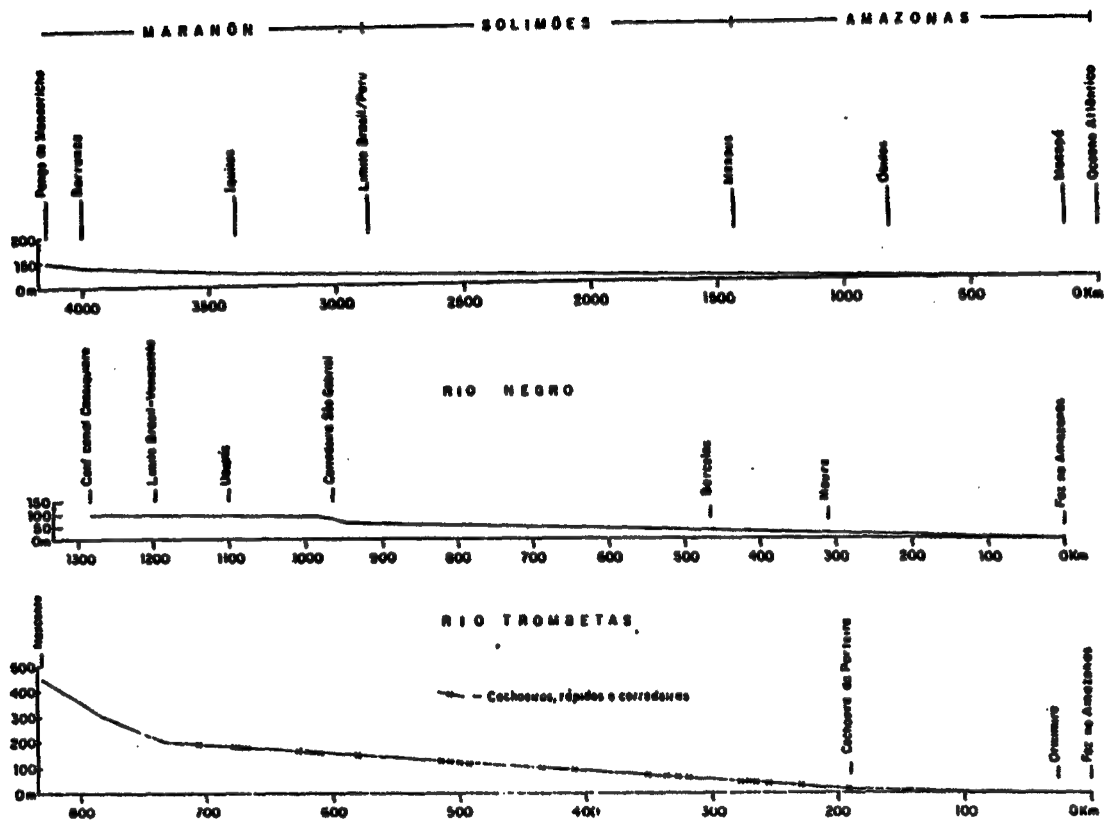


Figure 20 : Profiles of the Rivers Amazon (including Solimões and Marañón), Negro, and Trombetas.

Source: Soares (1977).

over 1,000 km long, and many of them are among the largest in South America (Kovzel, et al., 1978: 377; Rzoska, 1978:39). Furthermore, Fittkau (1967), according to Sioli (1975b: 477), stated that the surfaces of Amazonian rain forest streams when put together would correspond to an area many times that of the Amazon itself, and that their lengths when added to each other represent more than a thousand times the Amazon River's length.

As discussed above, the rainfall distribution along the year over the region varies depending on the location and specially from hemisphere to hemisphere. This pattern is reflected in the regime of the various rivers which are then integrated in the Amazon River's regime. Therefore, the flow in the Amazon River varies little from year to year. Despite the fact that the two basic rainfall patterns occur in the basin during different periods of the year, the Amazon River itself has only one annual peak. This peak has occurred most often in June, though in some years it has occurred during May or July. During the three highest water months (April to June), the flow of the Amazon River equals 40 percent of its total annual volume. The occurrence of only one period of high water is explained by the existence of an overlap of water supply coming from the two rainfall regimes. Similarly, there is generally only one low water period which occurs most often in October but having also been observed in November and December. During low water periods, 14 percent of the river's annual flow takes place (Sioli, 1975b: 467; Soares, 1977: 109-11; Yudina, 1978: 386).

The Amazon water level amplitude varies depending on the point along its course where the measurement is made. It usually decreases as one goes from the West to the Atlantic Ocean. At the middle of the Solimões River, it is up to 20 m; at Manaus near the mouth of the Rio Negro, 10-12 m; at Santarém in Pará State where the Tapajós River reaches the Amazon, 6-7 m; and near the Xingú River's mouth, the amplitude of the Amazon River waters is just 4 m (Sioli, 1975b: 467). Those are average values and significant floods are possible. In the Manaus area, for instance, Soares (1977: 116) has referred to the occurrence of 23 great floods and 7 exceptional floods during the period 1903-1976.

The whole Amazon Basin is frequently divided into three different geographical parts, which differ markedly in their river morphologies. The first section is the upper Amazon Basin. It is a vast, wide and uniform, lowland located between the Andes and the confluence of the Rio Negro with the Amazon. Rivers in this section--e.g., Rio Jurua, Rio Purus--are characterized by their endless meanders, very frequently cut off and formed into oxbow lakes. The second stretch, the middle Amazon Basin, goes from the limits of the upper Amazon to the mouth of the Xingú River. This section is a relatively narrow furrow between the north and south edges corresponding to the Guiana and Brazilian highlands. It is in this section that the "Mouthbays" of some tributaries to the Amazon best develop. Last, the lower basin, which goes up to the Atlantic Ocean and contains the "tunnel-shaped estuarine section of the Amazon where

the river divides into several arms which flow around the Island of Marajó." (Sioli, 1975b: 465)

The water quality of the rivers in the Amazon Watershed is not uniform. Sioli (1975b) citing an earlier work (1965), classifies these waters in three basic types--white-, black-, and clear-water rivers. Although the diversity of water types is in fact much greater (Junk & Furch, in press; cited by Junk, 1979: 37), this model clarifies some of the basic attributes of these waters as well as relates them to environmental conditions of the areas where they flow (Sioli, 1975a). Table 3 relates the three types of water with their environment.

The white-water rivers are characterized by a clayed yellow (turbid) water caused by suspended sediment concentrations of around 100 ppm (Sioli, 1975a: 283). They have the highest chemical concentratations of the three types of waters, containing soluble salts of magnesium, potassium, calcium, and others, PH is neutral and transparency (Secchi disc) varies from 0.1 to 5 m (Sioli, 1975b: 473-5). The origin of these waters, although not totally understood, is related to a strong erosion process as Klinge et al. (1981: 22-3) discuss:

> It has been speculated that the origin of the suspended silt in the white water rivers was once thought to be in the Andean headwaters, but it is more probably derived from the foot zone of the Andes where the rivers leaving the mountains flow over soft tertiary sediments, and through their meanderings carry off much of this old alluvial land. Simple surface runoff apparently plays a minor role in the origin of the suspension load of these rivers.

This suspension load later reaches the lower Amazon deposition

Table 3 : Amazonian Water Types as Expression of the Environmental Conditions in their Headwaters Areas.

Water Types	Black Waters	Clear Waters	White Waters
Water Color	Olive to coffee-brown, Transparent	Yellow olive-green, clear, transparent	Clayey yellow turbid
Headwater Area and its Relief	Plain lands	+/- plain lands as shields of central Brazil and the Guianas, Terciary terra firme of Amazonia	Mountains and mountain slopes (as primary suppliers of suspended matter
Soils	Podsols (bleached sands)	Brown clays	Brown clays and moraines in high altitudes
Vegetation	Caatinga, sandy campo, campina	Dense amazonian high forest (at least gallery forests in southern and northern border zones of Amazonia	Andean high forest (with solifluction), non forest vegetation
Examples	Rio Negro, Rio Cururu, creeks from campinas	Rio Tapajós, Rio Xingu, most creeks of Terciary terra firme	Rio Amazonas, Rio Madeira

Source: Adapted from Sioli, 1975a: 286.

and erosion floodplains--*varzea*.

Black-water rivers are characterized by its olive to coffee-brown color, and Secchi disc readings of 1.3 to 2.3 m. In addition, these waters are nutrient poor and contain high amounts of dissolved organic humic matter. Black-water rivers are extremely acid, reaching pH values bellow 4 (Sioli, 1975a: 284; 1975b: 473-5). The characteristic color of these rivers is caused by the dissolved organic humic matter. This humic matter is derived from decaying vegetation and soil humus occurring in a short and more open type of vegetation (*Caatinga* or *Campinarana*) which covers a very flat region subject to flooding for various months. In these areas, Spodosol soils of pure white bleached sands are found--and where the podzolization process occur--and whose drained water form black water creeks (Sioli, 1975a: 284; Cochrane & Sanchez, 1982: 144-5). The classical example of this type of river is the Rio Negro.

Clear-water rivers are characterized by a lack of humic matter, and also have low tranparency--0.8-4.3 m (Secchi disc)--due to a small amount of suspension load. Values of pH range from 4.5 to 7 (Sioli, 1975a: 285; 1975b: 473-5). Their origin is in the igneous and metamorphic insoluble rocks of the Guianan and Brazilian Shields. These regions are less flat and are forest-covered zones, an important factor in reducing erosion in those areas and, thereby, in reducing the amount of suspended particles in the clear-water rivers (Sioli, 1975a: 285).

Sioli (1975a:279), citing Katzer (1983) and his earlier works

(1967, 1968), observes that in the middle and lower Amazon basin, most rivers are extremely poor and pure in terms of chemical contents. "Except for the flood land of the Amazon river and some creeks, all rivers, clear as well as black ones, are best described as slightly contaminated distileted water." (Sioli, 1975a: 279)

The Amazon lowlands have extensive floodplains. Varzea, as mentioned above, is the local name given to the floodplains of white water rivers inundated for several months each year, and which are formed by recent alluvions. As discussed above, white-water rivers carry a substantial load of sediments. The "fresh and relatively nutrient-rich products of the weathering crust of the Andes" are transported down these rivers where they have been deposited and eroded on their way many times (Sioli, 1975b: 472). "As a result of (the) ... strong current, the bottom load ... is moved down the river in the form of real 'dunes' of coarse sand, grant ripple marks of up to 180 m in length and 8 m in height." (Sioli, 1953 cited by Sioli, 1975b: 462)

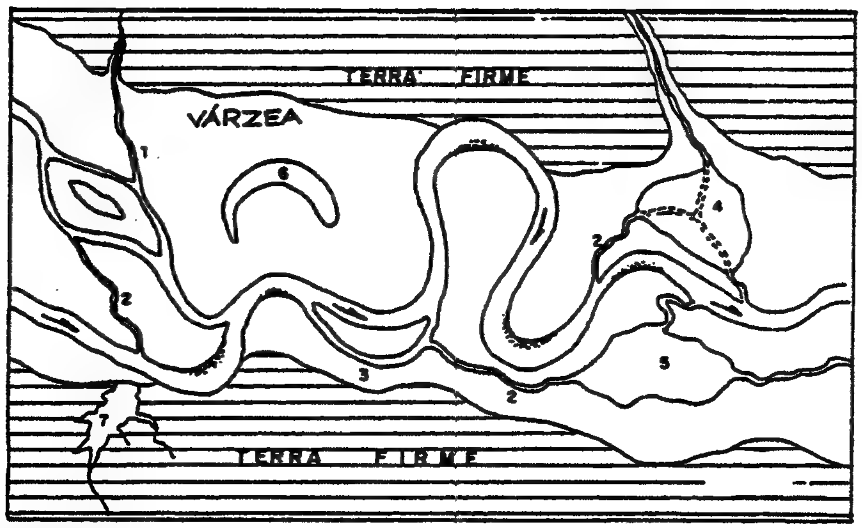
The várzea starts small in the lowlands of the Marañon and Solimões Rivers and, as one goes down the river, it becomes larger and larger. This is so because at the higher lands the rivers' currents are so strong that it does not allow deposition of sediments (Marlier, 1973: 228; Sioli, 1975b: 472). However, in the lowlands of the Amazon River and to a smaller extent in some of its white-water tributaries--e.g., Purus, Madeira, Jurua Rivers--, the streamflow velocity decreases and the sediment load of these waters can be deposited on the floodplains. The width of the varzea is not uniform;

it can vary from a few hundred meters to scores of kilometers--in some cases as many as 100 km--, although in some cases it does not exist as when the river touches the terra firme flanks (Soares, 1977: 137; Moreira, 1977: 15; Sioli, 1975b: 471).

Terra firme is also a local name given to the higher grounds of firm land flanking the floodplains, and which are never toached by the high waters. While várzea is formed by Holocenic (Recent) sedimentary deposits, terra firme is composed by older Tertiary sediments of the Barreiras series--fresh water sediments of the Pliocene (Sioli, 1975b: 464). Figures 21 and 22 present, respectively, a view from above and a transverse section of the floodplain revealing many of its features.

As seen in figure 21 , the várzea area is a complex and dynamic landscape, subject to deposition and erosion of sediments, low and high water periods, and with temporary and permanent lakes, channels, islands. The deepest parts of the várzea terrains are occupied by shallow lakes with depthd in the low-water season as low as 2 m or less, but sometimes covering areas of more than 1,000 km^2. Other areas in this same drier season may dry completely. "There are no true lakes in Amazonia, all standing waters are created by the river system." (Rzoska, 1978: 39-40)

Natural channels connect the várzea lakes with the main river, and through them not only water moves in and out with the passage of the high water season, but also aquatic animals. This and other features of the várzea discussed below are very important ecologically (Sioli, 1975b: 472).



1- Igarapé- a water course of small width and lenght, but with well defined watershed.

2- Furo- canals which in the varzea establish communication between the principal river and a tributary above the main confluence.

3- Paraná- an extense and deep arm of a big river forming a big islang in the varzea. Paranas are permanently navigable.

4- Creeks in temporary lakes.

5- Permanent lake.

6- "Separated" meandre lake.

7- Dammed lake in old fluvial via.

Figure 21 : Schematic View of the Lower Amazon River Valley (Seen from Above) (adapted from Soares, 1977: 139).

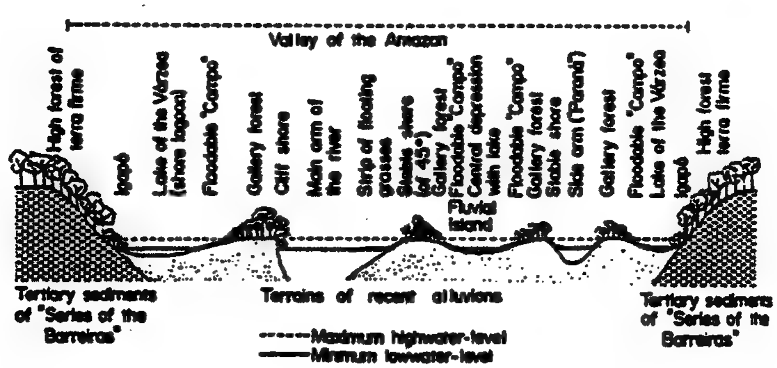


Figure22 : Schematic Transverse Section Through Lower Amazon Valley (height exaggerated) (after Sioli, 1975b).

The total area occupied by the várzea in Amazonia has been estimated to be more than 50,000 km^2 (Sioli, 1975b: 467), or reaching 64,400 km^2 in the Brazilian Amazonia as suggested by Camargo (1954, cited by Soares, 1977: 135). The várzea, therefore, form a prolongation of the Andean strip of material along the Amazon River.

The huge quantities of water and sediments that are transported in the Amazon River finally reach the Atlantic Ocean with such a pressure that the current is pushed far out into the sea bringing fresh water as far as 150 miles beyond the outlet (Furneaux, 1969: 4). The Amazon current is progressively bent toward the North due to the influence of the equatorial ocean current. Part of the large quantities of sediments brought by the river has "formed a true várzea along the Guiana coast, north of the principal outlet of the (Amazon) river."(Marlier, 1973: 228-9) At its mouth the Amazon River, is 208 miles wide, including the estuary of Pará. There it is found the Marajó Island; the greatest of many islands in this area, and which is the same size as Switzerland (Furneaux, 1969: 4-5).

A last aspect of the Amazon River watershed that has to be mentioned relates to the peculiar large bays found at the mouth of some Amazon affluents. Mouthbays, as Sioli has named them, are formed by the lower course of most affluents of the Amazon River in the middle basin and of the lower part of the upper basin. When these rivers, which while flowing over the highlands have "normal" bed, enter the Amazonian lowlands, their beds widen enormously--over 100 km long in the case of the Tapajós River--and their currents slow down

considerably and may even become completely lost.

The morphological features of these mouthbays are much closer to a lake than to a river. For instance, no erosion is observed to occur at a mouthbay's bottom. This led Sioli to refer to these areas as Amazonian river-lakes. The small amounts of suspended particles that most of these rivers carry when they arrive at these areas, then start to settle creating a series of elongated islands in the first sections of the mouthbays (Sioli, 1975b: 468-9).

As is the case with the bed of the lower and middle Amazon River, the bottom of these mouthbays are well below sea level (Marlier, 1973: 228). One of the explanations offered to explain this phenomenon was offered by Sioli (1975b: 470) who states that they may be geologically interpreted as "'downed valleys', drowned by the rise of the Ocean level after the glacial periods."

II.4 Soils

Early European narturalists visiting Amazonia, including some prominent ones like Humboldt and Wallace, were quick to relate their previous experience in their native countries with what they saw in the region. They thought that the exuberant tropical forest found in Amazonia, as discussed below, hid rich soils. They predicted that these forests could be converted into productive pastures and cultivated fields to produce every variety of produce with half the labor and time than in their native Europe. Humbolt went on to state that sooner or later Amazonia would become the bread basket of the world (Jordan, 1982: 394; Schubart et al., 1984: 26; Wallace, 1895). In many Brazilian minds, including in those of public officials, these predictions are still alive. As discussed in this section, the scientific knowledge obtained in recent decades about the soils of Amazonia indicate a different picture. This apparent paradox of rich forests growing on poor soils is explained in the next chapter.

Scientific understanding about the soils of the region has really increased only since the beginning of this century, especially after the 1950s. It was since then that collaborative work between the Brazilian government and bilateral and multilateral organizations combined with the efforts of several individual researchers have substantially increased our knowledge (Falesi, 1974 : 201-2). In particular, it should be mentioned the various works done in collaboration with FAO-UNESCO and which culminated with the publication

in 1971 of the volume IV (South America) of the collection Soil Map of the World. But perhaps the most important and comprehensive contribution for the knowledge of the Brazilian Amazon soils has been given by the RADAMBRASIL Project.

The presentation of the data collected through this work, however, has lacked in terms of synthesis of the enormous amount of information collected. This drawback has been in the process of being overcome via the creation and operation of an information system for geo-environment data (SIGA) which is being undertaken by the same project. SIGA is a computerized system which, among other activities, will be able to provide summerized information for the region.

Meanwhile, CIAT--Centro International de Agricultura Tropical, (International Center for Tropical Agriculture) a nonprofit organization devoted to the agricultural and economic development of the lowland tropics with headquarters located in Cali, Colombia--in collaboration with several South American government Agencies--in Brazil with the Empresa Brasileira de Pesquisas Agropecuarias-EMBRAPA (Brazilian Enterprize for Agricultural Research--using data collected by the RADAMBRASIL Project and other sources, developed in 1980 a state of knowledge report on the soils of Amazonia (Cochrane & Sanchez, 1982). The Amazon Region defined by this study includes areas beyond the Brazilian Amazon. It includes all the land area between the latitudes of 4 degrees north and 12 degrees south and between longitudes of 48 degrees west and the Andean mountains. (See figure 23.) These limits correspond to a total area of 484

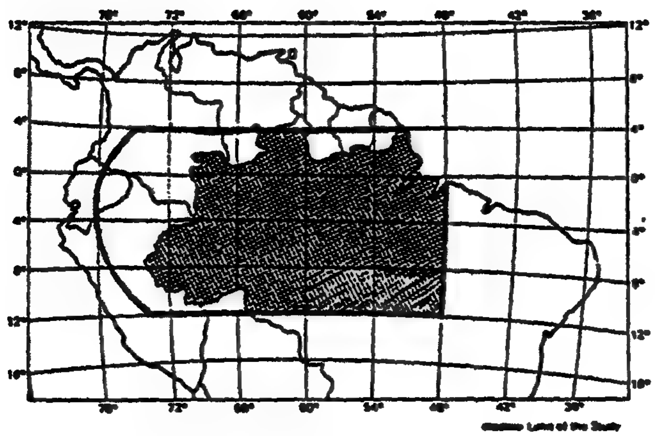


Figure 23 : Amazon Basin as Defined in the Soil Study by Cochrane & Sanchez (1982).

Source: Modified from Cochrane & Sanchez (1982).

million hectares (Cochrane & Sanchez, 1982 : 141). Due to the aggregate nature of the information provided in this study it will not be possible to restrict the discussion to the Brazilian Amazon.

The data provided in this study is, however, still exploratory in nature and subject to change once new and better information is obtained. One evidence of the exploratory nature of this study is given by the fact that the available data was agregated at substantially large basic cells of 6,800 ha each in order to be computerized (Cochrane & Sanchez, 1982: 140; 151).

The study utilizes a soil classification scheme developed by the US Soil Survey Staff (1975) and "that is similar to plant taxonomy in the sense that only properties that can be measured qualitatively are included" (NRL, 1982: 40). Since most of the original data available for the region uses other classification systems, a summary of soil equivalence between the soil taxonomy classification and the Brazilian system and the FAO legend is presented in appendix 5.

Table 4 and figure 24 present a summary of information compiled by these authors. It can be seen that almost 90 percent of the soils of the region are classified in three soil orders: Oxisols, Ultisols, and Entisols. The Oxisols of Amazonia are the largest not only in South America but in the world (Foth & Schafer, 1980: 452). These soils correspond to 45.5 percent of Amazon region as a whole and to about 75 percent of the Brazilian humid tropics--which correlates roughly with the north geopolitical region of Brazil (Serrão, et al., 1979: 199). They are found "mainly in the areas geologically affected

Table 4 : Distribution of Great Groups by Climatic Subregions and Topographic Position. Percentage Figures Refer to Slopes. (Climatic Subregion D Covering 2.51 Million ha Excluded.

Order and Great Group	Total area	Subregion A - Rain forests				Subregion B - Seasonal, semi-evergreen forests				Subregion C - Savannas			
		Poorly drained*	Well drained			Poorly drained*	Well drained			Poorly drained*	Well drained		
			0-8%	8-30%	>30%		0-8%	8-30%	>30%		0-8%	8-30%	>30%
	Million hectares												
OXISOLS:													
Haplorthox	134.8	-	33.0	16.7	6.2	-	49.8	20.2	5.1		3.6	0.3	-
Acrorthox	67.5	-	1.7	1.3	0.8	-	31.6	22.0	5.7	-	3.5	0.8	0.1
Acrustox	6.6	-	-	-	-	-	-	-	-		5.2	1.2	0.2
Haplustox	4.8	-	-	-	-	-	-	-	-		3.1	0.8	0.9
Eutrustox	2.0	-	-	-	-	-	-	-	-		1.4	0.6	-
Plinthaquox	0.9	-	-	-	-	0.9	-	-	-	-	-	-	-
Eutrorthox	0.3	-	-	-	-	-	0.3	-	-	-	-	-	-
Total	216.9	-	34.7	18.0	7.0	0.9	81.7	42.2	10.8	-	16.8	3.7	1.2
%	100	-	17	8	3	1	36	19	5		8	2	1
ULTISOLS:													
Tropudults	83.0		21.2	2.4	0.1		40.8	14.9	3.6	-	-	-	-
Paleudults	29.9		7.9	1.0	-		15.0	6.3	0.6	-	-	-	-
Plinthaquults	12.2	3.6	3.5	0.2	-	0.3	0.1	-	-	2.2	0.1	-	-
Plinthudults	7.6	4.9	1.3	0.3	-	0.1	0.3	-	-	-	0.7	-	-
Tropaquults	7.1	0.8	0.1	-	-	6.2			-	-	-	-	-
Paleaquults	0.7	-	-	-	-	0.5	0.2	-	-	-	-	-	-
Rhodustults	0.5	-	-	-	-	-	-	-	-	-	0.4	0.1	-
Albaquults	0.1	-	-	-	-	-	-	-	-	0.1	-	-	-
Total	141.1	11.3	34.0	3.0	0.1	7.3	56.4	21.2	4.2	2.3	1.1	0.1	-
%	100	8	24	2	-	5	40	15	3	2	1	-	-
ENTISOLS:													
Fluvaquents	46.1	21.7	-	-	-	23.6	-	-	-	0.8	-	-	-
Troporthents	6.9	-	0.7	2.0	3.8	-	0.1	0.1	0.2	-	-	-	-
Tropaquents	6.1	-	-	-	-	0.6		-	-	5.5	-	-	-
Quartzipsamments	5.5	-	-	-	-	-	4.5	0.5	-	-	0.5	-	-
Tropofluvents	4.7	-	2.0	-	-	-	2.2	0.1	-	-	0.4	-	-
Psammaquents	2.8	2.3	-	-	-	0.1	-	-		0.4	-	-	-
Hydraquents	0.6	-	-	-	-	0.5		-	-	0.1	-	-	-
Total	72.7	24.0	2.7	2.0	3.8	24.8	6.7	0.7	0.2	6.8	0.9	-	-
%	100	33	4	3	5	34	9	1	1	9	1		

Table 4: Distribution of Great Groups by Climatic Subregions and Topographic Position. Percentage Figures Refer to Slopes. (Climatic Subregion D Covering 2.51 Million ha Excluded. (Continued)

Order and Great Group		Subregion A - Rain forests				Subregion B - Seasonal, semi-evergreen forests				Subregion C - Savannas			
		Poorly drained*	Well drained			Poorly drained*	Well drained			Poorly drained*	Well drained		
			0-8%	8-30%	>30%		0-8%	8-30%	>30%		0-8%	8-30%	>30%
	Million hectares												
ALFISOLS													
Tropudalfs	6.6		0.2	-	-		4.5	1.7	0.2	-	-	-	-
Tropaqualfs	3.3	-	-	-	-	-	-	-	-	3.3			
Total	9.9		0.2				4.5	1.7	0.2	3.3			
%	100		2				46	17	2	33			
INCEPTISOLS													
Tropaquepts	10.6	4.2			-	6.0			-	0.4		-	-
Eutropepts	4.3		3.2	0.9	0.2	-	-	-	-	-	-	-	-
Dystropepts	0.6	-	-	-	-	-	-	-	-		0.6	-	-
Humaquepts	0.5	-	-	-	-	-	-	-	-	0.5	-	-	-
Total	16.0	4.2	3.2	0.9	0.2	6.0				0.9	0.6		
%	100	26	30	6	1	37				6	4		
SPODOSOLS:													
Tropaquods	10.5	8.4		-	-	2.1		-	-	-	-	-	-
MOLLISOLS:													
Argiudolls	2.8	-	1.4	1.2	0.1	-	0.1	-	-	-	-	-	-
Haplaquolls	0.9	0.6	-	-	-	0.3	0.1	-	-	-	-	-	-
VERTISOLS													
Chromuderts	0.5	-	0.5	-	-	-	-	-	-	-	-	-	-
Total	14.7	9.0	1.9	1.2	0.1	2.4	0.2						
%	100	61	13	8	1	16							

* Includes aquic and aeric subgroups.

Source: Adapted from Cochrane & Sanchez (1982).

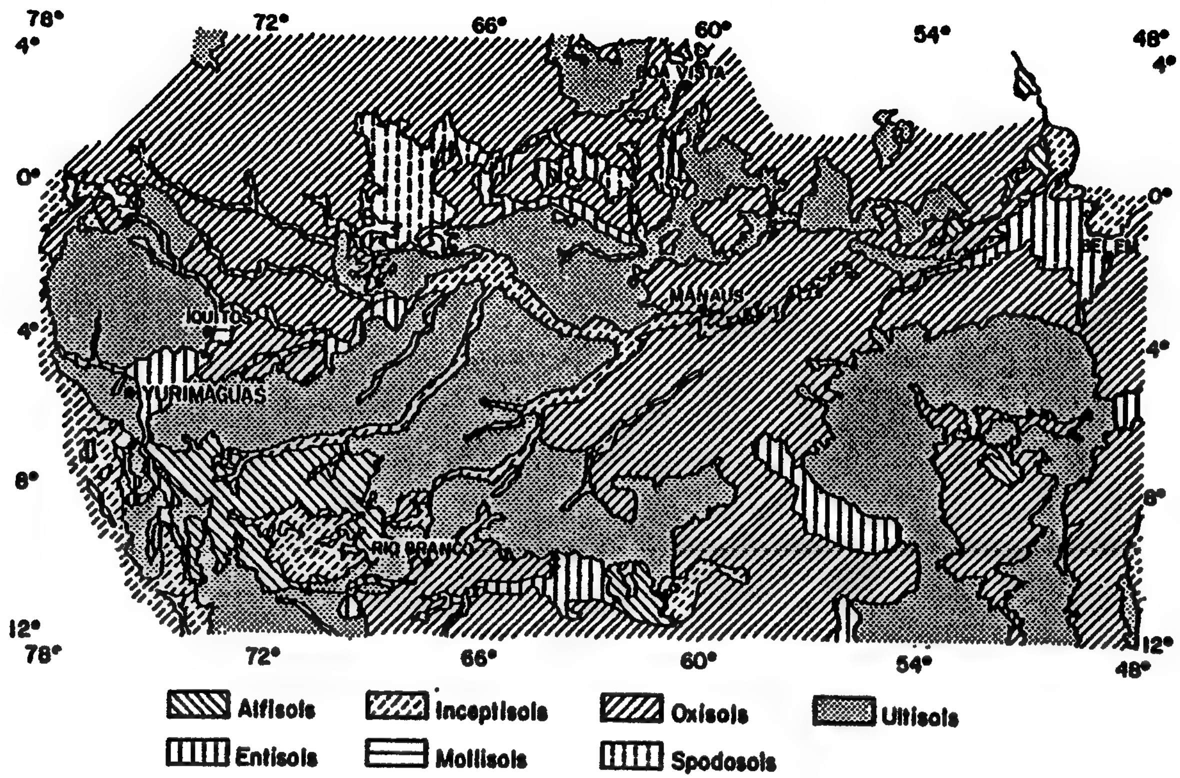


Figure 24 : General Map of Soil Orders of the Amazon Basin.

Source: After Nicholaides, et al. (1983) adapted from Cochrane and Sanchez, (1982).

by the Guyana and Brazilian shields ..., which are north east of Manaus" (Sanchez, 1980: 351), even though they have also been found occupying large areas on more recent depositional plains (Sanchez & Isbell, 1979: 32).

Although the soil taxonomy classification system is weak in dealing with Oxisols--other classification systems also have similar deficiencies--,, and the fact that these soils can be quite varied across the landscape--e.g., due to variations in parent material--(Foth & Schafer, 1980 : 445, 447); some characteristics common to all Oxisols can still be identified. Oxisols have their name derived from the presence of an Oxic B horizon of low activity clays consisting of Kaolinite, iron oxides and quartz. They are also low in weatherable minerals. The consequence of these features is that Oxisols have unfavorable chemical properties. They are poor in available natural fertility, acid, and have a high content of exchangeable aluminum leading to aluminum toxicity to plants. Physically, however, Oxisols have better properties. They are usually deep, generally well drained, with very good granular structure, and have uniform properties with depth. In terms of color they may be red or yellowish (Serrão, et al., 1979: 199-200; Sanchez, 1976 cited by Sanchez & Isbell, 1979: 51; Sanchez, 1980: 349,351; Cochrane & Sanchez, 1982: 167). In sum, Oxisols, the most abundant soil order in Amazonia, are poor chemically , but they have favorable physical properties.

The two great groups corresponding to more than 90 percent of the Amazon Region's Oxisols are Haplorthox--known in Brazil as Latasolo

Amarelo and classified by the FAO legend as Xantric Ferralsols--and Acrorthox. They both belong to the Orthox suborder--hot, nearly always moist soils--and generally have the basic features of the Oxisols. That is, Haplorthox and Acrorthox are well drained, uniform, have well granulated structure, but are very low in natural fertility. High clay contents are observed in many of them. What distinguishes these two soils from each other is that the Acrorthox soils have a lower cation exchange capacity of the clay (Foth & Schafer, 1980: 26; Cochrane & Sanchez, 1982: 153).

Ultisols is the second largest soil order occurring in Amazonia. They are found mostly west of Manaus, on some poorly drained landscapes, on other well drained areas not affected by the Brazilian and Guyanan Shields, and on the more dissected parts of these shields (Sanchez & Isbell, 1979: 32; Sanchez, 1980: 351; Cochrane & Sanchez, 1982: 154). Ultisols are very similar to Oxisols. They " are usually deep, well drained, red or yellowish soils, somewhat higher in weatherable minerals than Oxisols but still acid and with low fertility." (NRC, 1982: 44) A marked increase of the clay content with depth deferentiates Ultisols from Oxisols. Most Ultisols are highly weathered soils with oxic chemistry and mineralogy, formed on parent material of acidic nature and on a range of landscapes from youthful to very old (many of them are more susceptible to erosion since they occupy steep slopes). In sum, Ultisols are soils with similar chemical characteristics to Oxisols--acid, poor in natural fertility--, but their physical properties are not as good as that of the Oxisols

(Sanchez & Isbell, 1979: 32; NRC, 1982: 44).

Almost 80 percent of the Ultisols belong to the great groups Tropudults and Palendults, both of the soil suborder Udults—temperate to hot soils, never with more than 90 cumulative dry days in the year. The difference between these two great groups is the clay bulge depth in the subsoil, which is not agromically very important. Paleudults can occur in well and poorly drained upland of subregion A. (See figure 16.) When on well drained areas, they, besides being acid and infertile, are also susceptible to compaction due to a low clay content. On the other hand, the poorly drained ones have very high exchangeable aluminum (Foth & Schafer, 1982: 27; Cochrane & Sanchez, 1982:154).

As can be seen from the discussion above of Oxisols and Ultisols, these two soil orders are very similar to each other. Moreover, in many cases it is difficult to differentiate between them (Sanchez & Isbell, 1979: 32 citing Isbell, 1979). When added, these soils correspond to almost 75 percent of all soils of Amazonia—and probably a larger proportion of the Brazilian Amazon.

> In practice, ... (Oxisols and Ultisols) can be considered together; they encompass most of the 'red' soils of ... (Amazonia). Their main limitations are chemical: high soil acidity; aluminum toxicity; deficiency of phosphorus, potassium, calcium, magnesium, sulfur, zinc, and other micronutrients; and low effective cation-exchange capacity, which last indicates a high leaching potential. Also, Oxisols and Ultisols with clayey topsoils exhibit high capacity to immobilize phosphorus, but this constraint is less important in those soils with sandy or loamy

> topsoils. The organic matter of ... (the soils in those orders) is adequate (Sanchez, 1976). Their physical properties are generally excellent, and some Ultisols that have pronounced increase in clay, with depth, are very subject of erosion. (NRC, 1982: 44)

Entisols (Fluvaquents), Inceptisols and Mollisols are soils found along the flood plains of the rivers and correspend to 13.4 percent of the Amazon Region. They, as well as other Entisol suborders, show little or no development of the soil profile essentially due to their recent development. Entisols are divided into four suborders. The first one, Aquents, corresponds to 9.3 percent of Amazonia and are characterized by being seasonally or perenially wet soils. The second, Orthents, are shallow soils found on steep areas or near rock outcrops and cover 1.4 percent of Amazonia.

Psamments, the third suborder, are deep yellowish sandy soils, often very acid, and with natural fertility even poorer than the Oxisols and Ultisols. They cover some 5.5 million ha and are found in the headwaters of the Tapajos River and scattered around the Rio Negro basin in Brazil and Venezuela where they are formed from old erosion surfaces. Last, the Fluvents, which correspond to an area of 4.7 million ha along rivers. These well-drained young alluvial soils subject to no periodic floods, are among the best soils in the world (Sanchez & Isbell, 1979: 36; Foth & Schafer, 1980: 25; Sanchez, 1980: 353; NRC, 1982: 46-7; Cochrane & Sanchez, 1982: 154).

Inceptisols, another type of alluvial soil, are young but with sufficient age to develop horizons A, B, and C. Of the three major kinds found in the humid tropics, two exist in Amazonia: (1) Aquapts,

poorly drained Inceptisols occuring in the older alluvial plains along the major rivers and inland swamps, including the varzeas; (2) Tropets, well drained soils of a nonvolcanic origin (NRC, 1982:45-6).

Alfisols, in many instances, are very similar to Oxisols and Ultisols not only in terms of color, but also they are deep, well drained, and have other morphologic characteristics in common. In fact, Altisols can be separated from Oxisols and Ultisols only with the help of chemical Analysis. The chemical difference is that Alfisols have moderate to high fertility due to a higher base content, and hence, are not as acid as Oxisols and Ultisols. "By definition, base status is the proportion of calcium + magnesium + potassium + sodium in the exchange complex of the soil. High base status is good; low base status is bad, because it implies a high level of aluminum." (NRC, 1982: 47) Terra Roxa Estruturada soils and other Alfisols are found in "spots" in Oxisol and Ultisol dominated areas. They have their origin in the weathering of basic rocks—e.g., basalts—and have been found in the lower Amazon in the municípios of Alerim, Alenquer, and Monte Alegre; near Altamira along the Transamazonica highway and in Conceição do Araquaia in the southwest of Pará state; in the município of Araquaia in Northern Goiás state; near Porto Velho in Rondonia state; near Rio Branco state of Acre (Aubert & Tavernier, 1972: 19; NRC, 1982: 47-8; and Falesi, 1978: 208 citing his and other authors' works).

Spodosols are soils derived from coarse, sandy material found primarily along the headwaters of the Rio Negro in Northwestern Amazonas

state and federal territory of Roraima. These soils are extremely poor in natural fertility, very susceptible to erosion, and are found under Campinarana—a native forest vegetation lower and more open than the forests found on Oxisols and Ultisols, and which reflect a dry season soil moisture stress. These soils, as discussed above, are accountable for the chemical characteristics of the black-waters of the Rio Negro. This soil order covers a total area of 10.5 million ha in Amazonia, but, because of its concentration on the areas mentioned above, they acquire special local interest although for the entire region they correspond to only 2.2 percent (Sioli, 1975a: 284; Cochrane & Sanchez, 1982: 144-5). Well drained soils with relatively good native fertility and physical properties correspond to 6 percent (31 million ha) of the Amazon region as defined by Cochrane & Sanchez (1982). These include the following soils: Tropudalfs and Paleustalfs, Eutropepts, Tropofulvents, Argiudolls, Eutrustox and Eutrorthox and Chromuderts (Cochrane & Sanchez, 1982: 155).

Plinthite (Laterite) hazard has been of concern to early soil students in the region. For a long time it was generally believed that once Amazon soils were cleared they would be irreversibly transformed into hardened laterite. To avoid confusion, agriculturalists and pedologists now prefer to use the term plinthite instead of laterite to refer to the material capable of hardening if exposed by erosion. It is estimated that the soils containing soft plinthite in their subsoil—Plinthaquox, Plinthaquults, Plinthudults—total 21 million ha, 4 percent of the Amazon Region. Furthermore, most of these soils are

found in flat, poorly drained sites which makes it difficult for erosion to occur, diminishing the chances of laterite formation (Sanchez, 1980: 352; Cochrane & Sanchez, 1982: 155-6; NRC, 1982: 44-5).

The texture of the region's soils is summarized in this paragraph. Around seventy-two percent of the soils of Amazonia have a textural class loamy (18-35 percent clay) both by the topsoil (0-20 cm depth) and subsoil (21-50 cm depth), and loamy in the topsoil combined with clayey (more than 35 percent of clay) in the subsoil. Twenty-one percent of the remainder soils have a uniformly clayey profile up to 50 cm deep, and the balance is made up of shallow soils over rocks—0.4 percent only, which implies that the soils of the region generally do not offer physical barriers to root development—and other textural combinations (Cochrane & Sanches, 1982:158). Besides its importance in determining air and water movements, soil structure is an important information because when combined with information about an area's topography and vegetation cover, they determine the erosion hazards of the area. More on the erosion hazard of the soils of Amazonia is discussed below when the soil as a resource (as oposed to being an abiotic element of the ecosystem) is analyzed.

To sum up, throughout much of the geological history of Amazonia, heavy rainfall and the consequent leaching combined with high temperatures and intense biological activities affecting Amazonian soils and their parent materials, have resulted in specific soils characteristics. The great majority of soils of Amazonia are poor in natural fertility, low in effective cation exchange capacity (implying

susceptability to leaching), and acidic, though they have generally good physical characteristics. The Amazon Region has been referred to as heaven for scientists interested in studying nutrient deficiencies. Besides being naturally poor in the macro nutrients nitrogen, phosphorus, and potassium, the most widespread nutrient deficiencies are magnesium, sulfur, and zinc. Phosphorus deficiency is found in most soils of the region, although 16 percent of the area shows problems of high phosphorus fixation, among other reasons, because Oxisols of Amazonia are not generally high phosphorus fixers. Soils with low potassium reserves cover about 242 million ha of the region--56 percent. Some 64 million ha have low effective cation exchange capacity in the topsoil and 40 percent--192 million ha--have it in the subsoil mainly in regions B and C. (See figure 16.) This characteristic is an important one because it implies that those soils are very susceptible to leaching of mobile nutrients in the soil profile. These losses of nutrients caused by this leaching can create serious nutrient imbalances among cations such as potassium, calcium, magnesium. Around 81 percent of the Amazon Region soils have pH values below 5.3. This indicates not only an acid reaction, but, most importantly, it also indicates the probable presence of toxic levels of exchangeable aluminum and manganese as well as calcium and magnesium deficiencies. These consequences of an acidic soil affects adversely the growth of plants. In fact, some 315 million ha (73 percent) of Amazonian soils in their natural state are considered aluminum toxic to plants, i.e., they have 60 percent aluminum saturation or more within

the top and subsoil (Kamprath, 1972: 137-8; Sanchez & Isbell, 1979: 41; Cochrane & Sanchez, 1982: 153, 164, 167, 170-1).

Notes for Chapter II

Section II.3

1. "It is true that there are winds from the east quadrant in the troposphere above the friction layer, but these winds bring ... little moisture; they reach the upper Amazon only after a long way accross the continent." (Ratisbona, 1976: 266.) See also Eidt, 1969: 59.

2. Free translation by the author.

CHAPTER III

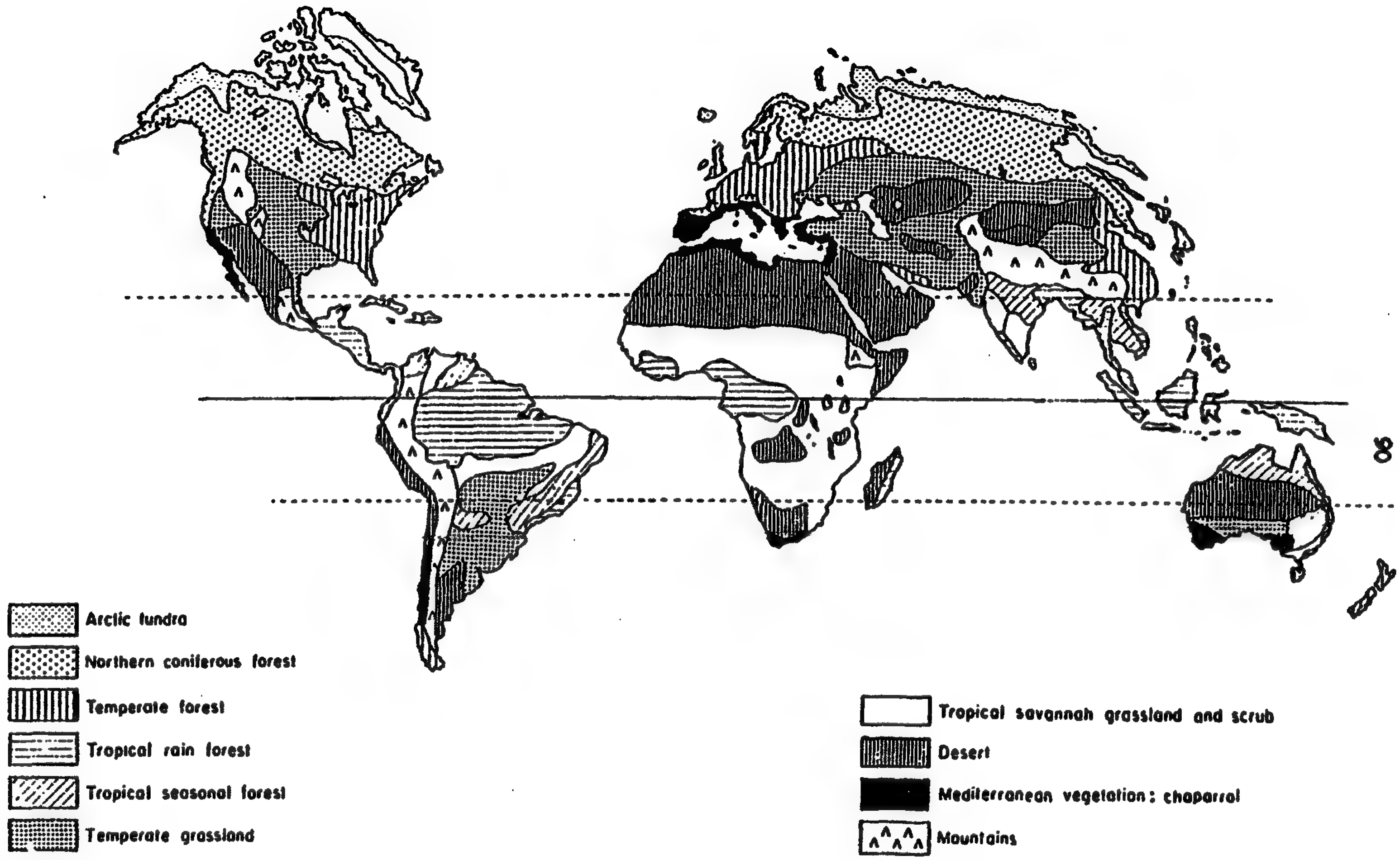
Biotic Components of the Ecosystem

III.1 Amazonian Tropical Forest and its Functioning

Throughout the natural history of Amazonia, the abiotic components of its ecosystem discussed above, through an interactive process, resulted in the formation of one of earth's biologically most diverse, oldest, most complex, and least understood biomes: the tropical moist forest. The dominance of this type of vegetation in Amazonia is one of its most outstanding characteristics. As shown in figure 25, this biome occurs also in Africa and Asia though it is in Tropical America that it is most abundant. Of the total of over 1.2 billions of closed[1] tropical forests found in the world by a FAO/UNEP (1981a) study, more than half is located in this region. In Tropical America, the 670 millions of these forests are found not only in the Amazon and Orinoco River Watersheds, but also in the Atlantic coast of Brazil, the upper Pacific coast of South America, Central America, and Mexico. Brazil alone, however, possesses a little over 50 percent of Tropical America's closed tropical forests amounting to a total of over 357 millions ha. (See table 5.) Most of the Brazilian closed tropical forests are found in Amazonia.

The single broad category of closed tropical forest used by FAO/UNEP to summarize their study's results does not emphasize the various types of vegetation found in Amazonia. But, there is no sole

Figure 25: Distribution of the Major Terrestrial Biomes of the World.



Source: adapted from Cox & Moure (1980).

Table 5 : Closed and Open Forests in Selected Countries of Tropical America, Africa, and Asia, 1980. (In Thousands of ha.)

Country	Total Area	Tropical Forest Closed	Tropical Forest Open
BRAZIL	851,196	357,480	211,200
Peru	128,522	69,680	1,120
Colombia	113,889	46,400	5,700
Bolivia	109,858	44,010	24,700
Venezuela	91,205	31,870	3,300
TROPICAL AMERICA	1,679,121	678,655	278,647
Zaire	226,760	105,750	71,840
Congo	34,200	21,340	a
Gabon	26,767	20,500	75
Cameroon	47,544	17,920	7,700
Madagascar	59,099	10,300	2,900
TROPICAL AFRICA	2,176,279	216,634	486,445
Indonesia	191,930	113,895	3,000
India	328,700	51,841	5,393
Papua New Guinea	46,170	34,230	3,945
Burma	67,658	31,941	a
Malaysia	33,008	20,995	a
Philippines	29,940	9,510	a
TROPICAL ASIA	944,769	305,510	30,948
WORLD	4,800,169	1,200,799	796,040

a = no data; in most cases this is where the areas are very small.

Source: Modified from OTA, 1984: 323, 326, after FAO/UNEP, 1981a.

vegetation classification system widely accepted. Examples of some systems were shown above as basis for climate type classification. Other vegetation classification types are found in the studies by the Instituto Brasileiro de Geografia e Estatísticas- IBGE (Brazilian Institute for Geography and Statistics) and in the works of Hueck(1972), Pires(1974), and others. But, as is the case for soil data, the most detailed and best quality data available on Amazonian vegetation is also provided by the project RADAMBRASIL. Table 6 shows, for a 342 million ha portion of Amazonia as shown in figure 26, the several broad categories[2] of vegetation found by the survey project. Nearly three-fourths of the surveyed area was classified as forest types which accounts for 251 million ha dominating the Amazonian vegetation physiognomy[3].

One of the basic features of tropical forests is their species diversity. These forests tend to be high both in the number of plant and animal species per unit of area as well as in their relatively uniform number of individuals. Though the number of tropical species is high, most of them occur at very low densities. Amazonia, in terms of diversity of species, is the richest of all tropical forests or any other similar-sized region on earth, though Southeast Asia is probably the richest per unit of area. The total number of plant and animal species on earth is far from being known, and preliminary and exploratory estimates put this total number anywhere from 5 to 10 million species. Only 1.6 million were actually known to science up to 1979. Amazonia's share of the estimated total is thought to be

Table 6: Vegetation Types of Part of Amazonia According to RADAMBRASIL.
(In thousands of hectares.)

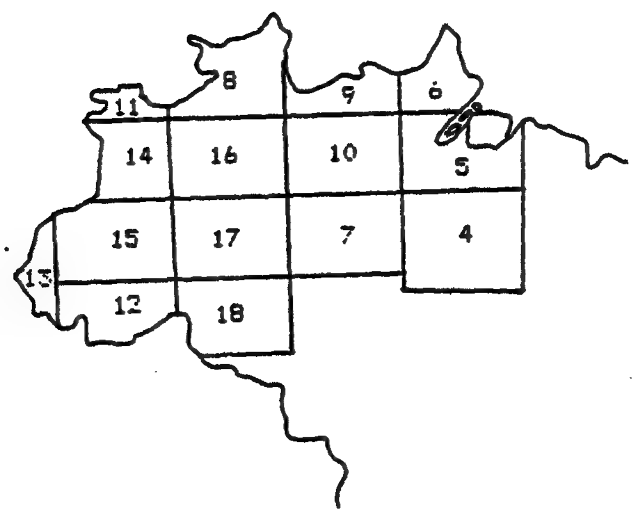
Volume	Total	Tropical Forest Dense	Tropical Forest Open	Savanna	Campinarana	Ecologic Tension Area	Pioneer Formation
4	36,683	13,350	14,184	2,325	0	3,765	0
5	28,478	19,623	1,755	552	0	848	2,194
6	13,645	8,819	0	940	0	145	2,025
7	29,375	16,903	10,346	151	0	1,650	0
8(a)	25,074	11,771	539	2,566	152	4,390	3,600
9(b)	14,855	11,876	562	615	0	610	30
10	29,516	22,639	89	94	0	2,891	601
11	7,320	833	134	0	2,134	4,076	0
12	17,920	4,299	13,296	0	0	0	28
13	17,964	8,605	823	0	1,084	6,273	21
14	7,587	1,269	6,062	0	159	0	0
15	28,480	12,733	15,368	0	0	21	11
16	26,211	3,192	16,448	1,533	0	3,814	155
17	29,376	12,933	5,308	194	0	3,199	621
18	29,516	14,967	1,895	0	1,908	8,745	74
TOTAL	342,000	163,812	86,809	8,970	5,437	40,427	9,360

(a) Only part of this sheet is included. There are also 284,200 ha of Semi-Decidual Forests and 106,290 ha of Steppe - Savanna.

(b) Only part of this sheet is included.

Source: Modified from Projeto RADAMBRASIL (Divisão de Vegetação), 1978: 24.

Figure 26: Map Showing the Location of RADAMBRASIL'S Volumes.



possibly 1 million whereas all tropical forests may have between 2 and 4 million species (Lovejoy, 1982; Myers, 1979: 16, 23, 131, 134; 1984: 50; NRC, 1982; Richards, 1977: 227).

In terms of flowering plants, the tropics are estimated to have at least two-thirds, and possibly 75 percent of all higher plants on earth. Of the total estimate of 250,000 plants species identified so far, 90,000 are thought to be found in tropical forests, out of which the moist forests of Amazonia contain an estimated minimum of 30,000 vascular species. Mosses, lichens, liverworts, algae and fungi are also numerous in the tropics which are thought to house 110,000 out of the 145,000 contained in the world (M yers, 1984: 50, Myers, 1979: 22-3; Owens, 1971 cited by Myers, 1979: 23).

Animal species are also very numerous. Most living mammal species are already known to science, except for bats. The Neotropic biogeographic region has some 17 mammal families endemic to the area including 2 families of the Edentata Order (anteaters), 11 families of the Rodentia Order, 2 families of Primates, one of Marsupialia and one Insectivora family. Some 810 species of mammals--including the world's largest rodent, Capivara or water pig (Hydrochoerus)--distributed among 278 genera have been found in the Neothopics, whereas the more and usually large popular African mammal fauna has 756 species distributed over 240 genera (Keast, 1969 cited by Bourliere, 1973: 279; Myers, 1979: 21; Pielou, 1979: 10-1). Tropical America has three families of forest-inhabiting Primates (no Primates have adapted to savanna environments), 16 genera, and 42 species. In the Brazilian Amazon,

there are 14 primate genera with a total of 32 species, 5 of which and as many as 30 subspecies are found nowhere else (Bourliere, 1973: 28; Fittkau, 1968: 624; Rylands & Mittermeier, 1982: 22; UNESCO/UNEP/FAO, 1978: 147).

Like mammals, most bird species are also already known to science. The avifauna of South America is extremely rich in species and endemic families. Some 27 families have been found in the region in which 1,668 species are distributed; some families with as few as one species and other families with 365 species. Amazonia has been mentioned to have 550 bird species* among which the smallest species of humming bird on earth (Amadon, 1973: 275; Fittkau, 1968: 624; Olrog, 1968; UNESCO/UNEP/FAO, 1978: 146).

Fresh water fish species are not as well known. While the Congo system has 560 fish species, the Mississippi 250, and the whole Europe only 192 species, the entire number of fish species for Amazonia is estimated to reach from 1300 to 2,000 with representatives from all taxa. Among these species is found Arapaima Gigas, the largest--reaching up to 3 meters long--bony freshwater fish in the world (Brown, 1975: 210; Gery, 1968; M yers, 1979: 23, 1984; Roberts, 1973: 240; Sioli, 1975b: 476).

The least known and also the most numerous--probably comprising three-fourths of all animal species--are the insects. Among Amazonian insects there is the 19 cm long beetle Titanus gigantous. Insects are found almost everywhere and they show substantial rates of endemism. For instance, known South American butterflies--the richest

in species--are distributed in 13 families, 618 genera and 1,912 species; 90.8 percent of the species are endemic to the region. New insect species are frequently being found and their systematic study is yet in a rather preliminary stage (Brown, 1973: 171; Illies, 1968: 705; M yers, 1979, 1984; Lewis, 1973 cited by UNESCO/UNEP/FAO, 1978: 150).

Various explanatory theories for the exceptional biological diversity found in the tropics and combinations thereof have been developed. Some suggest that part of this diversity is the result of mechanisms developed for the escape from predators and diseases (Shubart, 1983: 125). The great age of those forest ecosystems--estimated to be 70 million years--is thought to have allowed evolution to happen nearly uninterruptedly and, consequently, permitted substantial niche speciation (M yers, 1984; Richards, 1969).

Other theories try to explain the tropical species diversity based on an allopatric speciation mode. This mode establishes that speciation occurs due to reproductive isolation of two or more subpopulations resulting from their separation from a single original species population. If the barriers causing this separation last long enough preventing the intermingling of their offspring, then new species may differentiate. These barriers can be of several nature (Pielou, 1979: 82-3). As discussed above, during the course of Amazonia's natural history various barriers appeared that may have resulted in new species differentiation. Haffer (1981: 376-9) has classified the following vicariance events in decreasing order of geological significance: (1) geological breakup and drift; (2) uplift

of the Andes, (3) the differential erosion of these uplifted areas, (4) precontinental seas, (5) climatic-vegetational variations due to glaciation and non-glaciation periods, (6) changes of world sea level creating islands or connecting previously isolated ones, and (7) the formation of the Amazon River system.

The allopatric differentiation resultant from these geologic events, especially items 5, 6, and 7, combined with speciation due to long-distance dispersal and through sympatric and parapatric differentiation modes are suggested by Haffer (1981, 1982) as important to explain the biological diversity of tropical forests. Of those, event 5 has given rise to the much debated (c.f. Prance, 1982a) Quaternary Refuge theory. The importance of this theory is in the fact that it tries "to explain the latest and perhaps most effective of the series of differentiation events beginning during the Mesozoic that contributed to the development of the modern biotas of the world." (Haffer, 1982: 10)

The Quaternary Refuge[s] Theory is based on the fact that the effects on climate during the Pleistocene ice age (as shown in figure above) were not restricted to the ice-covered regions. The unglaciated areas suffered the worldwide changes in atmospheric circulation caused by the presence of huge ice sheets in high latitudes as well as the changes in sea level with amplitude of as much as 200 m between glacial epochs when sea water was used to form ice sheets and non-glacial periods when the world was practically ice free.

In Amazonia, dry-cool periods were experienced when glaciation

occurred and warm wet periods during the non-glacial periods. The periods of cooler and drier climates appear to have affected the forest cover of Amazonia causing it to considerably reduce in size and to be replaced by drier, more open vegetation types such as savannas and caatinga. These reduced forest patchs, called refuges, isolated from each other by other types of vegetation are assumed to have lasted throughout these glacial epochs, a sufficient time period for species populations to become extinct, to survive unchanged, or to differentiate to the level of subspecies or species. When warmer and wetter periods of the non-glacial epochs returned, the forest refuges expanded over the savanna-caatinga vegetation inverting the situation by creating savanna and caatinga refuges in the forest dominated region. Evidence of this is the fact that it is not unusual to find the occurrence of obviously xerophylic plants--plants adopted for growth with a limited water supply--within the moist forest area of Amazonia today as well as xerophytic adaptations of moist forest plants. Since the current period is a non-glacial period, it is thought that the non-forest vegetation types mentioned above to exist in the Amazon region may be in fact present-day refuges[4].

The Quaternary Refuge Theory is supported by data sets derived from independent sources like geoscientific studies (paleobotany, geomorphology, geology), and biogeographic studies leading to coincident conclusions. Despite this evidence, there are doubts about the extent to which this theory is an explanation for the species diversity of the present tropical forests (Fairbridge, 1977; Haffer,

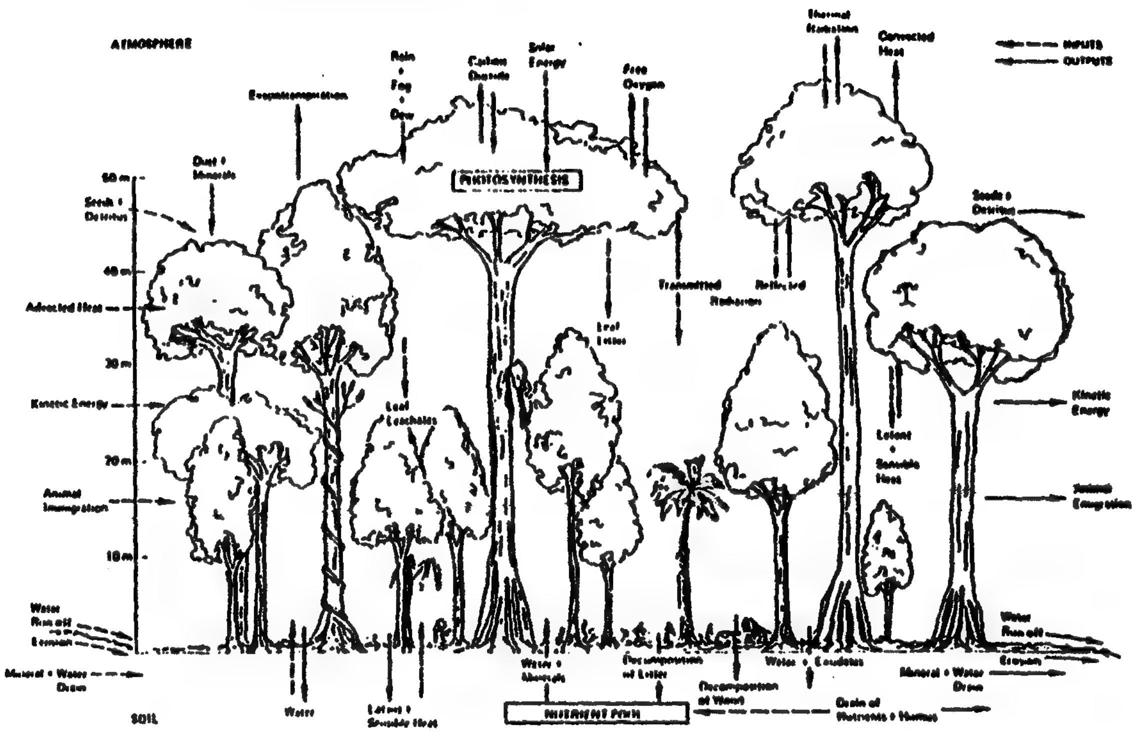
1969, 1981, 1982; Prance, 1982a, 1982b, 1982c; and others in Prance, 1982a).

As discussed below, the concept of the Quatermany Refuge Theory has been an importance criterion for the identification of conservation units in the Brazilian Amazon which have been designed to coincide with Quaternary refuge areas empirically located.

The huge diversity of life forms found in tropical forests, which the Quaternary Refuge theory tries to partially explain, has made these forest the most complex ecosystem on earth. There are countless relationships that these species have with each other and with their abiotic environment, which itself is also very diverse at a local level of analysis. Figure 27 presents a general profile of a closed tropical moist forest and its inputs and outputs.

Besides the diversity of species and abiotic environments and the various types of vegetation, the moist forest itself has a structure that leads to the formation of several niches. There is variation of microclimates from the canopy to the forest ground. In physical terms, the canopy is more exposed to light, wind, and hence suffers a greater range of temperature and humidity. Whereas on the other extreme of the forest structure, the ground is not affected by winds and is more uniform in temperature, humidity, and other characteristics due to the insulation provided by the canopy. Biologically these differences are also reflected in the animal and vegetal composition of these areas. For instance, many of the insect species being currently discovered by scientists are found only in the

Figure 27 : Diagrammatic Representation of Inputs and Outputs in a Humid Tropical Forest.



Source: NRC, 1982: 52.

forest canopy which until recently was for most practical purposes, unaccessible. Because of this, the canopy of the tropical forest has been called the last biotic frontier.

The vegetation is the basis of this complex ecosystem. Besides providing shelter, energy, and other required growth conditions for plants, animals, and microorganisms, the vegetation also provides protection to the soil by absorption of radiation, precipitation, and wind. Photosynthesis produces the energy to this system which is transfered to grazers and from them to carnivores and finally to decomposers. For instance:

> The moist forest of the central Amazonian terra firma is characterized by a very high number of dicotyledonous trees and by a great proportion of palms and lianas ... Total plant biomass of the forest is about 1100 mt of fresh matter per hectare while its animal biomass is only 0.2 mt per hectare. Invertebrates predominate. Insects are well represented. Soil fauna, comprising approximately 50-75 percent of the animal biomass, is the most important group from the point of view of ecology and energy flow. Living plant matter apparently does not serve as the main food base of animals. Seven percent of the animal biomass feeds on living matter, except wood, and and 19 percent feeds on living and dead wood. About half the animal biomass feed on litter, mainly after it is converted into fungal mycelia.
>
> The food chain is thus built up on transformed litter. Twenty-four percent of the animal biomass is carnivorous and about 2 percent is omnivorous (Fittkau & Klinge, 1973: 10-12).

There is substantial competition for food and other scarce environmental resources such as light and nutrients. To improve their chances for survival, many species rely on mutualistic relations with other cooperating species. Many animals not only obtain their food from plants but they also improve the plant's chances for successful

reproduction by polinizing them and dispersing their seed. To attract polinators and repel predators, certain plants produce alcaloids--secondary components to the plant since these chemicals, despite helping their survival, are not essential for growth--which have been found to be useful for medicine, agriculture, and industry. Certain plants and fungi also associate symbiotically to form mycorrhiza whereas others, mostly belonging to the legumenosae family, associate with nitrogen fixing bacterias. (Canfield, 1985: 59-61; Goley, 1983a; Gottlieb & Mors, 1978; M yers, 1984; Miller, 1984; UNESCO/UNEP/FAO, 1978; NRC, 1982; Richards, 1973, 1977; Schubart, 1983).

Várzea forests have also developed special relationships with river animals. The trees of these forests are capable of standing inundation for a few months without dying. When the water level goes down these trees begin to bud, and by the time the waters start rising again, they will be blooming and bearing fruits. Various fish species, the Amazonian mamatee (Trichechus inunquis) and other animals come to the várzea area where they find protection and feed upon these fruits and other plant parts. It is during this food abundant period that most fish species accumulate fat that they use through the low water period when they literally fast until the next flood of the várzea. The flood plains are thus one of the main zones of primary production and of utmost importance for fishery in Amazonia (Goulding, 1979, 1980, 1981; Junk, 1983: 58-60).

Within limits, tropical moist forests are renewable due to their capacity to regenerate themselves. This feature of the moist forest is

of fundamental importance for its management by man. Primary tropical forests are in climax and thus do not produce net biomass, but this equilibrium is dynamic. Regeneration takes place naturally through a process of secondary forest succession of disturbed areas that may result from storms, death and fall of old trees, river floods. A rapid colonization of such breaks follows by pioneer fast growing heliophytes from dormant seeds available in the soil and by seedlings or seeds of tall primary tree species which increase their growth rate in the disturbed area, though the latter type of trees is usually slower in growth than the secondary (pioneer) species. Vegetative reproduction by means of rhizomes, bulbs, and roots that may remain alive after disturbance of the original forest can also be observed. After several years, the primary trees grow taller than the secondary when the primary natural ecosystem is regenerated.

But the primary tree seeds are usually large, have a short dormancy or none at all, and apparently have limited long distance dispersal which reduce the capacity of the primary forest to regenerate the rate itself when the disturbed areas are large. This fact makes the tropical moist forests very fragile to human interventions that result in large scale deforestation.

Unless very long fallow periods are permitted, and a primary forest gene pool exists nearby, these areas are for all pratical purposes irreversibly degraded which may result in loss of species (Gomes-Pompa, 1972; Schubart, 1983: 126).

As discussed above, most Amazonian soils are poor in natural

fertility. This fact contrasts with the existence of the luxuriant and species-rich tropical forest in an apparently paradoxical situation which led many of Amazonia's first students to erroneously predict the region's high capacity for agricultural production. But how can such a forest prosper in such a poor substract? The answer to this question lies in the fact that, unlike other vegetation system in which the mineral of the soils are an important component of nutrient cycle, in the Amazon moist forest cycling of nutrients occurs rapid and efficiently above ground in the living and dead biomass. In these poor soil regions the rain fall is the most important source of nutrients.

A series of nutrient-conserving mechanisms have been identified as responsible for enabling the Amazon moist forest to survive and prosper on lower amounts of nutrients. The most important of these mechanisms are located in the sometimes thick (as much as 20-30 cm) mat of roots and humus that is found on or close to the soil surface and where over half of the fine feeder-root biomass is contained. Direct physical adsorption of the nutrients by this root mat is one of the most crucial of these mechanisms. Another important mechanism is the rapid growth of small roots in the mat which cover freshly fallen leaves, fruits, or branches. Because of the constant high temperature and humidity, decomposition of plant and animal remains rapidly releases the nutrients which are then recycled back into the growing plants, preventing mineral leaching. The nutrients from these decomposing material are also efficiently transferred to a root by mycorrhizal fungi, as mentioned above. Bacteria, Algae, and other

microorganisms found not only in the mat but sometimes on the surface of leaves of many plants also improve adsorption of nutrients by these plants from the environment.

Other nutrient conserving mechanisms of Amazonian moist forest include: (1) the existence of trees with low nutrient requirements and tolerant to high aluminum concentrations; (2) the prolongation of the useful lifetime of leaves reducing the requirements for additional nutrients needed to rebuild or replace leaves; (3) the existence of leaves with thick and leathery structure which may reduce nutrient losses by leaching during the intense rain falls and by decreasing vulnerability to damage by insect; (4) the retranslocation to the twig of large portions of the more mobile nutrients before some species shed their leaves; (5) the thickness of the bark of some trees which inhibits diffusion of nutrients from the phloem and thus reduce nutrient loss; and (6) the rapid colonization of disturbed areas, as discussed above, which incorporates nutrients into the biomass and thus prevents substantial losses of nutrients through leaching (Golley, 1983b; Herrera et al., 1978; Jordan, 1982; Myers, 1984: 75-9; Richards, 1973).

As mentioned above, the purity of the Amazonian watershed clear- and black-water rivers reflect both the poor nature of the region's soils and the effectiveness of the nutrient cycling in these tropical forests.

III.2 Man in the Pre-Columbian Amazonia

The time in which man first arrived in the New World is still a matter of controversy among New World archeologists. Nonetheless, most of them seem to agree that the first east Asians crossed the Bering Strait some 30,000 or more years ago. The Bering Strait was a land bridge connecting Siberia and Alaska created during periods of low sea level resulting from ice periods during the Pleistocene. At its maximum, this land bridge extended over 2,000 kilometers in width (Jennings, 1978; Meggers, 1979; Cox & Moore, 1980: 168). More agreement exists, however, about the proposition that the first immigrants lived in small groups composed of related families. They lived from hunting, and gathering of wild plants. They used stone tools which were not specialized and the same implement was often employed in cutting, scraping, and pounding (Meggers, 1979: 11).

However, the evidence indicates that it took a long time for man to reach South America. The oldest evidence of the presence of man here comes from sites dating prior to 12,000 BP. They have been found north and south of the Amazon Basin, as well as in Southern Pantagonia and Central Andes (Meggers, 1982: 486). The evidence about the arrival of man in the Amazonian lowlands indicate dates even more recent. This region is the only major area of the New World that has failed to produce either Pre-profectile Point or Paleo-Indian remains. No archaeological evidence prior to the introduction of pottery is

available from the current forest covered areas, although stone artifacts have been found outside Amazonia. This leaves the <u>Homo sapiens</u> prehistory in Amazonia still unknown (Meggers, 1979: 15; 1982: 485).

Several reasons have been suggested to justify the absence of earlier man evidences in the region. First, little archaeological work has been done and even this little has been limited to investigations of the more accessible margins of the várzea areas. Almost no information is available from the hinterland or from the major Amazon River tributaries (Meggers, 1979: 97, Meggers & Evans, 1978: 547). In addition, less than one percent of the known archaeological sites have been dated (Meggers, 1982: 495). Another reason is the absence of suitable stone raw material which make it probable that tools, weapons, and containers in the Amazon were made of wood, bone, and other perishable materials which do not survive in the wet tropical climate (Meggers, 1979: 15, 124; Meggers & Evans, 1978: 547; Meggers, 1971: 35). Next, the dense vegetation, which besides being a difficult environment for archaeological research, masks the ground surface, hiding any objects that lie upon it (Megers, 1971: 35; Lynch, 1978: 495). Meggers (1971: 35) adds two other reasons for this lack of information about prehistoric man in Amazonia:

> (One is that) ... only settlements that remained for many years in one place would produce a noticeable modification of the soil to mark their location. ... (The other is that) the continual oscillation of the river channel, coupled with the annual alluviation, makes it unlikely that land suitable for settlement a few thousand years ago would still be accessible even if it remained intact.

These reasons, on the one hand, reduce the chances that much will ever be learned from preceramic inhabitants of Amazonia. But, on the other hand, the new research and dating of known and new sites could alter considerably what is currently interpreted as being the prehistory of man in this region (Megger & Evans, 1978: 547; Meggers, 1982: 495).

Another interpretation for the lack of evidence of early man in most of eastern lowlands of South America is provided by Thomas F. Lynch. He suggests that the heavily forested lowlands were disadvantageous for Paleo-Indians in the past glacial time, because he feels "'openness' ranked high on ... (their) list of desirable habitat characteristics" (1978:475). However, Betty J. Meggers argues that "it is reasonable to assume that Amazonia was inhabited by hunting and gathering groups as early as the surrounding region" (1979: 124). She bases her assertion on "the fact that wild food resources compare favorably with those of temperate forests and the evidence that bone projectile points were part of the Paleo-Indians tool kit (which makes) it unsafe to assume that this area was avoided by early hunting and gathering people" (1979: 15). Nonetheless, the fact is that there is a blank in this phase of the prehistory of man in Amazonia.

The archaeological record in Amazonia starts with the introduction of pottery making which consists of the principal surviving type of evidence from the region (Meggers, 1974: 97; Meggers & Evans, 1978: 558). Even though from the adaptation or survival viewpoints, pottery is not a cultural element of primary importance, it

has a major role in archaeological research in Amazonia for several reasons. It is a good indicator of sedentary life since it is not easily portable. Also, it is a sensitive index of social complexity changes and cultural relationship since it can be varied considerably without loosing its functions. In addition, it is durable, abundant, and possible to be made in many types of environments (Meggers, 1982: 491; 1979: 34-5).

> Tracing the distribution of distinctive varieties of vessel shape and decoration through time and space serves as a basis for the reconstruction of paths of diffusion and the recognition of significant advances in level of social development (Meggers, 1979: 55).

Thus, it greatly enhances the possibility for reconstructing Amazonian prehistory.

However, pottery is a relatively late phenomenon in the region. The first ceramic evidence from Amazonia was registered on the coast of Pará--the Mina Tradition--and was dated as occuring some 4,700 years BP. (Meggers & Evans, 1978: 551-4; Meggers, 1982: 491). But this tradition, besides being short lived, seems not to have been adopted by inland groups (Meggers & Evans, 1978: 554).

The appearance of ceramics of the Ananatuba Phase on Marajó Island also in Pará some 3000 years BP, characterize a second period of dispersal (Meggers & Evans, 1978: 558; Megger 1982: 491).

During the millenium preceding the Christian Era, pottery-making complexes persisted on the mouth of the Amazon. On the Island of Marajó, the Ananatuba tradition was assimilated by another

tradition--the Incised Rim tradition--of uncertain derivation (Meggers & Evans, 1978: 560-1).

> The earliest known pottery from middle Amazon dates near the beginning of ... (the christian period). It comes from Itacoatiare, on the left bank just below the Rio Negro. (Meggers & Evans, 1978: 569)

About 500 years AD, the Marajoara--Polychrome Ceramic Tradition--became widely distributed along the borders of the Amazon flood plain close to the coast. The best described village sites of this tradition are those of the Marajó Island and the available data imply this tradition to be more advanced culturally in every respect than previous inhabitants of the island. The villages were much larger, sometimes extending for a kilometer or more along the river bank. Among the features indicating social stratification and occupational specialization there has been found: "differential treatment of the dead, complicated decoration and standardized vessel forms, articles produced for ritual or mortuary use, and construction of large earth works" (Meggers & Evans, 1978: 569; Meggers, 1979: 124).

Also by 500 AD, pottery-making Indians were established along the Amazon River (Meggers & Evans, 1978: 571). For the next 500 years "the Polychrome Tradition expanded westward along the floodplains." Dates from several sites between the Madeira and Japura (Rivers) indicate a dispersal upriver from vicinity of the Rio Negro. At the mouth of the Amazon, the Marajoara Phase was undergoing a decline in general complexity" (Meggers & Evans, 1978: 576).

During the period between 1,000 and 1,500 years AD, the

continuity of the Polychrome Traditon was interupted and became restricted to the upper Amazon. By 1,300 AD it had penetrated to the middle Ucayali River in eastern Peru. The lower Amazon was intruded by the Amazonian Incised and Punctate tradition apparently from the north. One of the best known expressions of this tradition found in Amazonia was the Santarém culture, which flourished at the mouth of the Tapajós River. No other representation of this tradition has been reported occurring above the Rio Negro (Meggers & Evans, 1978: 580,587). It was during this same period that the Arua Phase replaced the Marajoara Tradition on the Marajó and other islands of the Amazon mouth (Meggers & Evans, 1978: 580). "During the final centuries preceding European contact, sedentary pottery-making (and presumably agricultural) groups were distributed over most of the tropical lowlands" (Meggers & Evans, 1978: 578).

Although a tremendous amount of data about the Amazon prehistory has been obtained in the past decade and a half, most of the heart of the region is still unknown (Meggers & Evans, 1978: 545). This absence of appropriate information, makes any attempt of reconstruction of the evolution of aboriginal cultural adaptation to the region to be regarded as mostly fiction (Meggers, 1971: 37). In this region, archaeologists are still attempting to construct the time-space prerequisite for the analysis of subsistence strategies, social systems, and processes of cultural change (Meggers & Evans, 1978: 547).

As in the case of other biotic components of the Amazon region,

there existed in the region a considerable heterogeneity, not only in general cultural terms (Meggers & Evans 1978: 583), but also in linguistic and indian physical types. Linguistic diversity in tropical South America has been considered by Mason (1959; cited by Meggers, 1982: 483) as the greatest in the world. In fact, more than 200 languages have been identified in the area and have been grouped in four basic linguistic families (Migliazza, 1982: 498).

Three main Indian physical types have been identified by Imbelloni (1950, cited by Willey, 1971) as occurring in Amazonia. The first and by far the most important physical group he called the Amazonides. "They are said to be Indians of medium stature, with well developed torsos and arms, but rather short, small legs." (Willey, 1971: 11). This type occurs over most of the Brazilian Amazon except in two areas, one on the Solimões-Jurua-Japura Rivers area and the other on the lower upper Tapajós River. In these areas as well as in the middle Araguaia-Tocantins and Xingu River area, the second Indian physical type Laguides, is found. They are described "as of short stature, dolichocephalic, high-vaulted, and wide- and low-faced." (Willey, 1971: 10). The last major group found in the Brazilian Amazonia is the Fuegides, who are located on the right side of the middle Madeira River. They are characterized as having a short stature, dolichocephalic, low-vaulted cranuim, a long and face, and a long narrow nose. Willey (1971: 9-10) cites two theoretical positions which try to explain the existence of the American Indian physical variability. One is that it is the result of a series of migrations

from the Old World to the New one. The other position—favored by Willey—explains this variability as being "a result of genetic drift and the separation of breeding populations within the Americas after their arrival from Asia." (Willey, 1971: 10)

The aboriginal diversity in linguistic and physical terms seems to just add to the general diversity of the Amazon tropical forests. Therefore it should be expected that some of the same proposed explanations for the biological diversity discussed above would be called upon to elucidate the matter. That is exactly what has been recently proposed, especially with respect to the Refuge Theory (Meggers, 1974; 1982; Migliazza, 1982). Meggers (1982: 495-6), for instance, suggests that this model, which, as mentioned above, also discusses the effect of climatic changes suffered in Amazonia for the past 10,000 years, "provide(s) an explanation for long range dispersals and other archaeological, ethnographic, and linguistic distributions." These recent developments may bring new light to the prehistory of man in Amazonia.

How successful has been the aboriginal adaptation to Amazonian environments? According to Meggers (1971, 1973, 1974) there are only two basic habitats in Amazonia with different subsistence potential sufficient to significantly affect aboriginal adaptation. They are the várzea and Terra Firme.

As discussed, most of the archaeological record in the region has been found in várzea areas. None of these cultures survived beyond the period of European contact. Enough information, however, has been

accumulated from early description by the explorers and from archaeological studies which combined have permitted reconstructions of the general cultural development level achieved in the floodplains in Pre-Columbian times (Meggers, 1971: 121-2).

Villages in the várzea area were located on the high banks, where they were secure from flooding while with easy access to the floodplains where the Indians hunted, fished, and planted (Meggers, 1973: 319). Each of these villages was densely populated, with numbers estimated to range between 300 to 2,500 individuals (Meggers, 1974: 106). They were among the most highly developed aboriginal societies in Amazonia (Meggers, 1974: 106; Dunevan, 1976: 208). The subsistence base of these communities depended heavily on the flood cycles of the Amazon River. (See figure 28.)

> Among the more advanced traits (of the varzea Indian groups) are social stratification, unification of a number of villages under the rule of high chief with considerable authority, occupational specialization, religious observances in the form of offerings to idols tended by full-time priests, and warfare for the purpose of taking captives who ... formed a separate servile class. (Meggers, 1974: 106)

As seen above, in varzea areas there is a concentration of rich resources. These include a large variety of fish, flocks of ducks and other aquatic birds, water turtles, numerous caymas, manatees, the aquatic plant Victoria regia, wild rice, and other grasses.

As the water level decreases many of these resources concentrate in or around the lakes and become increasingly easy to be captured. Especially during the low water periods, the Indians practiced hunting, fishing, and of gathering this resource base and

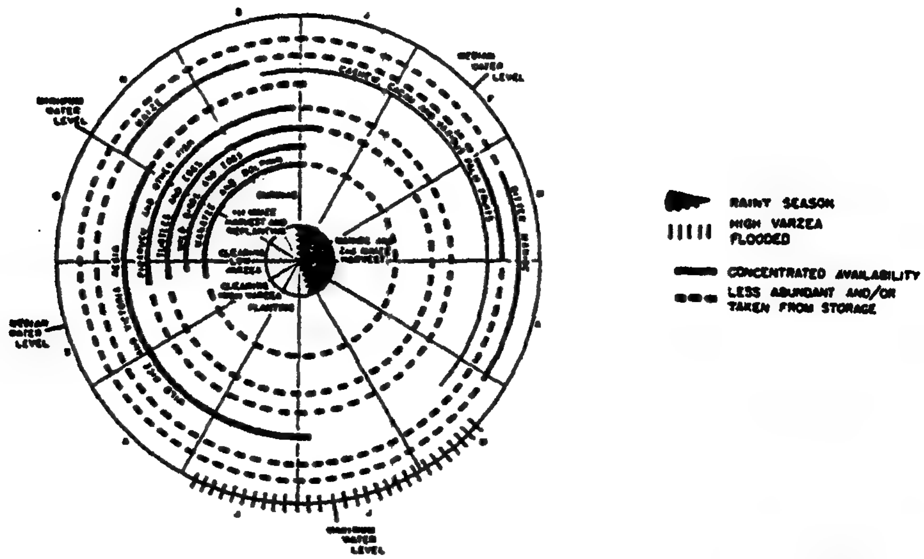


Figure 28: Annual subsistence round postulated for the aboriginal inhabitants of the várzea. Wild plant and animal foods are available in profusion during the months of October through December, when the water level is recending. Maize and bitter manioc, the principal agricultural crops, must be harvested before the fields are flooded. The fluctuation between feast and famine was mitigated by the development of a variety of methods for preserving and storing seasonally available foods.

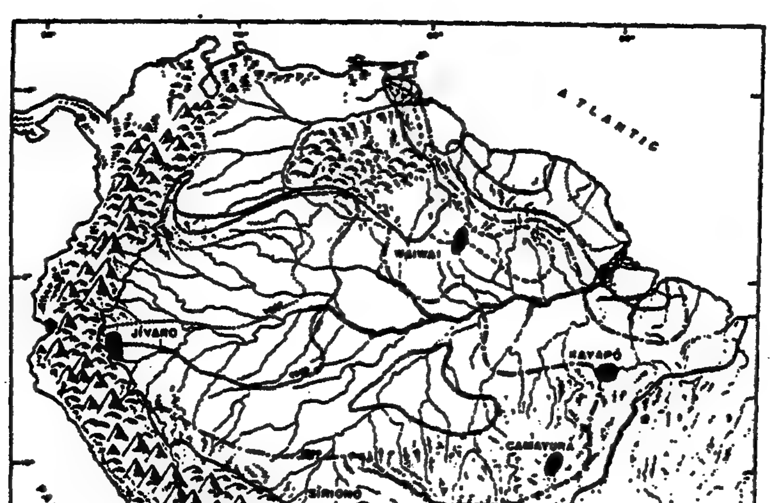


Figure 29 : Location of the five tribes selected to illustrate cultural adaptation to the terra firme environment. The heavy line defines the limits of Amazonia (after Meggers, 1971).

large quantities were obtained. They supplemented this food base with agriculture practices taking advantage of the annual renew of várzea soil fertility and of these easiness of clearing the land for planting—especially when compared to terra firme forest clearing. There they planted maize, which can only be planted in those areas since most terra firme soils do not support good corn and manioc crops. This abundance of food allowed the existence of a relatively dense population, which apparently remained indefinitely in the same location (Denevan, 1976: 208-9, 215; Meggers, 1971: 125-7; 1973: 312,319; 1974: 106, 1979: 125-7).

> (However,) ... in normal years, the peak of agricultural activity coincides with the period of greatest abundance of wild resources, so that hunting, fishing, gathering, and farming activities must be practiced simultaneously and sufficiently intensive to produce a surplus for consumption during the leaner months when inundation permits dispersal of the fish and destroys any crops left unharvested. ... The challenge of the (aboriginal adaptation in the) varzea is to minimize the detrimental effects on the human population of seasonal and sometimes unpredictable reductions in the normal level of subsistence support. (Meggers, 1973: 312-3)

Denevan (1976: 208-9) has suggested, that although the várzea location of these Indians is related to the soil fertility and to the ease of mobility, the most important factor seems to have been the availability of meat protein obtained from the rich wildlife resources. The lack of these sources of nutrition seems to be one of the principal constraints on the size of terra firme groups.

In contrast to the varzea and as further discussed below, the

aboriginal populations of the vast terra firme areas of Amazonia were little affected by the early European explorers. Although few archaeological investigations have been conducted in those areas, what is known indicates that the prehistoric pottery-making groups living there were similar in settlement pattern, material culture, social organization, and other respects to the surviving non acculturated tribes (Meggers, 1979: 127; 1971).

In terra firme, a much simpler way of life existed. The abundance of life observed in the varzea did not exist in these areas. This was due to the general characteristics of the Amazonian ecosystem discussed above. As seen, the majority of the terrestrial vertebrates, which was the primary source of protein for terra firme Indians, was small and in low density, making hunting productivity low and making game supply exhaustable within the village's influence area in a few years of use. Also the clear- and black-water rivers crossing terra firme areas are not abundant in fish resources, especially the black-water ones. Fruits and nuts are available in the appropriate season and some, e.g., Brazil nut, are highly nutritious allowing gathering activities to be profitable (Meggers, 1973: 312). Different Indian groups have adopted different ways to deal with this situation. Some groups are semi-nomadic while others have adopted practices that allow them to maintain their village indefinitely in the same location (Denevan, 1976: 208; Meggers, 1973: 314,318).

In cultural terms, a basic pattern shared by the several distinct aboriginal groups living in terra firme has been identified,

although many variations exist.

> This pattern was characterized by relatively small and frequently moved settlements, subsistence derived partly from wild foods and partly from slash and burn agriculture, social organization based on kinship and sexual division of labor, and ceremonial activities directed toward promotion of community cohesion and subsistence security. Warfare and blood revenge were widespread, provoked more often than not by the desire to take revenge for sorcery; acquisition of territory or material goods were never involved. (Meggers, 1974: 102)

The agricultural system employed by terra firme Indians is, therefore, different from that used the várzea ones. In the várzea they were subject to the variations in river water level, whereas in the terra firme the dominant factor is the rainfall pattern of the area where specific groups live. As a matter of fact, the rainfall pattern combined with the seasonality with which fauna and flora are made available, determine the groups' annual subsistence cycle.

Almost all terra firme residents practice slash-and-burn method of agricultural production. This method takes advantage of the regenerative capacity of tropical forests in relatively small areas in a similar manner to the regeneration of occasional disturbance of the forest by natural causes (Gomes-Pompa, et al., 1972). Meggers (1974: 105) summarizes the basic slash-and-burn used in the following way:

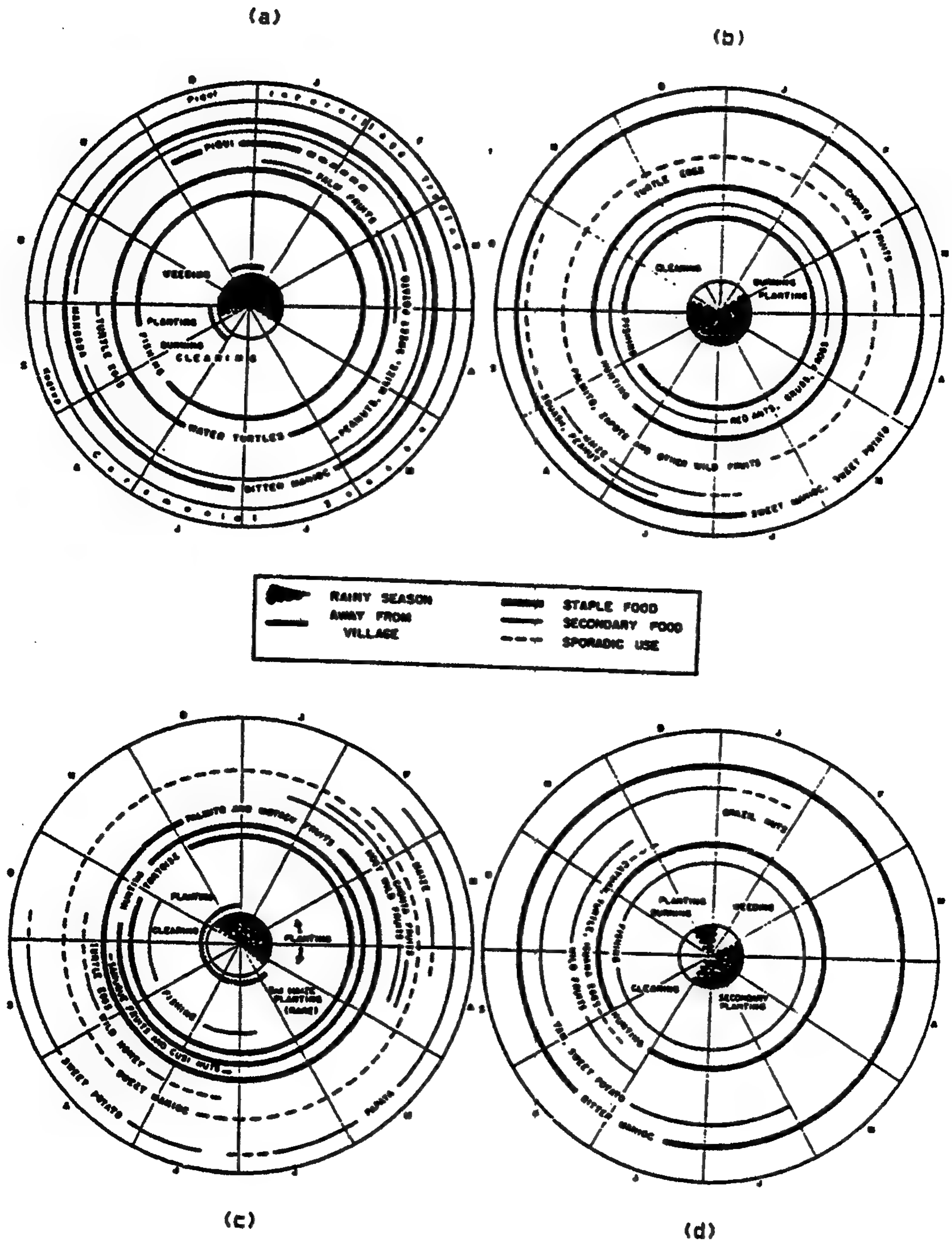
> Although there are innumerable variations, the basic procedure consists of clearing a path of forest, allowing the felled trees to dry for several weeks, and then burning them. If too many branches remain unconsumed, the smaller ones are removed before planting; trunks and large limbs are left on the ground. Manioc, sweet potatoes, pepper, and other cultigens are planted between unburned debris and may be weeded during the first few weeks. Manioc is propagated by cuttings and during the three years

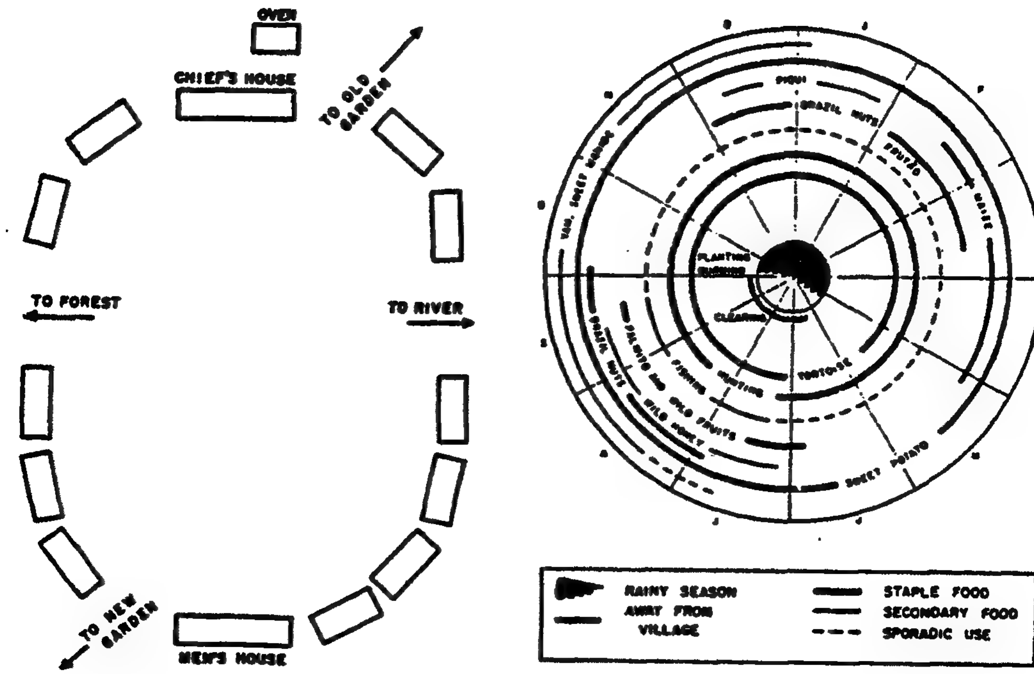
> that the average field is in use, replanting is generally done at the time of harvest. As a consequence of the protection by the unburned trees and the briefness of exposure of the soil before the cultigens sprout, damage from sun and rain is minimized. Although decay of trunks and branches (as well as the ashes resulting from burning return) ... nutrients to the soil, depletion inevitably occurs. The consequence is declining productivity, which generally requires abandonment of a field after three or four years. By this time, secondary growth has already begun, and the process of reincorporation into the surrounding forest continues until another period of agricultural utilization.

The burning of the forest liberates the nutrients which are in fact concentrated in the biomass, as shown in the previous section. As mentioned above, the subsistence pattern of the different aboriginal groups varies depending on various factors. Annual subsistence cycles are shown in figure 30 as examples of this. The geographic location of these groups is shown in figure 29 above. Here more details will be given about only one of them, the Kayapó as illustrated in figure 31. This Indian group occupies the region between the Rio Araguaia and the middle Rio Xingú in Pará state. (See figure 29.) In this area there is a dry period of several months which affects substantially their way of life.

> During the rainy season, the main emphasis is on garden produce, principally sweety patatoes. These are supplemented by maize, Brazil nuts, piqui fruits, game and fish... . Clearing of the fields is done by men, while planting and weeding are produced by family groups. Harvesting and food preparation are responsibility of women. The traditional dish is a kind of bread made from manioc, sweet patato, or maize dough. During the dry season, the community splits into extended family bands, which wander in distant parts of the forest subsisting on wild foods. Only persons too ill or

Figure 30: Annual subsistence round of the Camayura. Fish, water turtles, and bitter manioc are year-round staples. The village is abandoned twice annually to take advantage of seasonal subsistence resources: tutle eggs at the end of the dry season and piqui fruit during December and January. Other foods are of secondary importance. The marked seasonality of the rainfall has led to a concentration of ceremonial activities during the dry months (May to August), and to an emphasis on intervillage trade during the latter part of the rainy season when flooding permits shortcuts by canoe. (b) Annual subsistence round of the Jivaro. Fish, game, sweet manioc, and sweet patatoes are year-round staples. Chonta fruits and maize are important during a few months. Only sporadic use is made of wild plant foods. (c) Annual subsistence round of the Siriono. Game, land tortoises, palmito, and motaco fruits are the primary year-round staples. The principal agricultural crops--maize, sweet potatoes, and papaya--are available only for a few months. Sweet manioc is sporadically consumed throughout the year. A great variety of fruits, nuts, and other kinds of wild foods is eaten during most of the year. The marked seasonality of the rainfall has led to a pattern of alteration among the Siriono between dry season wandering and rainy season sedentariness. (d) Annual subsistence round of the Waiwai. Game and bitter manioc are the year-round staples, supplemented by fish. Yams and sweet potatoes are secondary crops. Although wild fruits, turtles, eggs, and other foods are exploited during certain seasons, gathering is not an important subsistence activity. There is no well-defined dry season and the group remains sedentary throughout the year (After Meggars, 1971).


(a)
(b)
(c)
(d)
RAINY SEASON
AWAY FROM VILLAGE
STAPLE FOOD
SECONDARY FOOD
SPORADIC USE
WEEDING
PLANTING
BURNING
CLEARING
FISHING
PIQUI
WILD FRUITS
TURTLE EGGS
WATER TURTLES
BITTER MANIOC
PEANUTS, MAIZE, SWEET POTATO
HUNTING
CHONTA FRUITS
SWEET MANIOC, SWEET POTATO
RED ANTS, GRUBS, FROGS
SQUASH, PEANUT
MAIZE
PAPAYA
SWEET POTATO
SWEET MANIOC
WILD HONEY
SECONDARY PLANTING
BRAZIL NUTS
YAM, SWEET POTATO
WILD FRUITS



(a) (b)

Figure 31 : (a) Plan of a Kayapó village. Communal houses, each occupied by a matrilocal extended family, are arranged around a plaza. Paths lead in four directions: to the river, the gardens, and the forest (from Meggers, 1971; after Frikel, 1968). (b) Annual subsistence round of the Kayapo. Game, Land tortoises, and sweet potatoes are year-round staples, while Brazil nuts and maize are primary foods during certain months of the year (July to Sptember), the village is abandoned except by the ill and infirm, and the population divides into extended family bands to wander through the forest subdidting on fish, palmito, Brazil nuts, and wild fruits (from Meggers, 1971).

> infirm to travel remain in the village in the care of a relative. (This requires a relatively large territory, but also allow the Kayapo to remain in the same location indefinitely.)
>
> Hunting is the favorite male activity and is often done in the company of relatives. Small animals are shared within the family, but large game, such as deer, tapir, and peccary, is delivered to the chief for distribution. Fishing is important during the dry season. Land tortoises, which abound in the region, are frequently kept alive until needed. Brazil nuts, ... are exploited during the dry reason and are also collected and stored during the period of sedentary village life. (Meggers, 1974: 317-8; see also Meggers, 1971)

The Kayapó Indians are devided in various villages--the largest political entity--of several hundred people which, despite their linguistic and cultural similarities, may confront each other in hostil activities. The household unit is a matrilocal extended family consisting of a woman--the head and owner of the house--, her married and unmarried doughters, and their children. Up to the age of seven, boys remain in constant company of his mother. At age of ten, however, they are sent to live in the men's house where they learn tribal customs, arts and crafts, hunting, and warfare. "At puberty, a boy enters the warrior class and embarks on the most prestigious and exciting period of his life. Since this status is lost with the birth of his first child, he attempts to postpone fatherhood as long as possible." (Meggers, 1973: 317) It is in the men's house that adult males decide about community matters. There is a village chief, but he has no coercive power and exercises leadership only because of his experience and good judgement (Meggers, 1971; 1973; 1974).

> The adaptive success of ... (the) cultural

> pattern in the tropical forest environment is attested to both by the leisurely of its unacculturated inhabitants and by the abscence of evidence for environmental degradation. Only a few hours per day provide an adequate food supply, and the annual subsistence cycle insures a balanced diet throughout the year. Although no community exploits all resources potentially available within its territory, the absence of nutritional deficiency deseases implies the achievement of a combination that supplies the vitamins and minerals essential to good health. (Meggers, 1974: 104-5)

The successful aboriginal adaptation to Amazonian environments should also be reflected on its Indian population before the arrival of the first Europeans. When these explorers arrived in Amazonia, they found numerous Indian villages in the Marajó Island and other varzea areas. In addition, the terra firme was occupied by large number of aboriginal groups spread in these areas. But how many Indians were there when the first european arrived? Denevan (1976) has addressed this question. Using a method of estimated population density at the time per type of habitat, combined with estimations of the total area of those habitats, he arrived at the conclusion that almost 5,000,000 Indians lived in the Amazon basin as a whole. For the várzea areas alone, he estimated the aboriginal population to be more than 900,000. If the total number of aboriginals in the Amazonian basin were reduced by 25 percent, as Denevan (1976: 234) does for the Great Amazonia (which by his definition includes areas of the Northeast, Southeast, and Central Brazil), to account for the possibility of the existence of buffer zones between hostily neighbor tribes pointed out by Myers (1976), this number would be reduced to 3,750,000 Indians; still quite a substantial population size.

Notes for CHAPTER III

Section III.1

1. According to OTA (1984: 65):

> Closed forest includes land where trees shade so much of the ground that a continuous layer of grass cannot grow. The tree cover is often multi-storied. Trees may be evergreen, semi-deciduous, or deciduous. Closed forests grow where the climate is relative moist. The data on closed forests areas do not include the land which is forest fallow, ... (or forest plantations).
>
> Open forest has trees that cover at least 10 percent of the ground but still allow enough light to reach the forest floor so that a dense, continuous cover of grass can grow. ... Open forests generally occur where the climate is relatively dry. The data on open forest areas do not include the land which is forest fallow.

2. Dense Tropical Forest: Tall, evergreen trees in well-watered and even climate regions. Open Tropical Forest: Trees more distant from each other with dense scrubs starey and correspond mainly to adverse edaphic or climatic conditions. Trees are mixed with lianas (cipo), bambu, or palm trees. Savanna (Cerrado): "Wooded savanna" with flexuous trees and always having a gramineous grass layer. It can vary from a fairly dense, multistoreyed vegetation with dominant trees as high as 20 m and relatively long straight boles (Cerradao) to only scattered shrub vegetation (Cerradinho). Campinarana: Scrubby forests on poor (Podzols or hydromorphic laterites) or water logged soils with impeded drainage, with high density of low (5-15 m), small-diameter (less than 20 cm) trees. Ecologic Tension Areas: Occurs when the floristic domains of different physiognomic forms are integrated in the same area. Pioneer Formations: Campo vegetation in areas of aluvial or maritime environments and constantly changing due to sediment deposition. Steppe - Savanna: Occurs in areas of extended dry periods and over dissecaded vulcanic rocks and dominated by thorny carmephyte and decidual phanerophyte or a gramineous carpet (Brown, 1982; FAO/UNEP, 1981b; Projeto RADAMBRASIL, 1978).

3. Appendix 6 presents an alternative set of vegetation data based on the work of IBGE.

4. Myers (1979: 23) has given to the Amazon Basin a much higher figure of over 1,800 species of birds.

5. The refuge concept was first developed by north temperate zone biologists studying the distributional history of the Paleartic and Neartic biotas during Pleistocene period. The Quaternary Refuge Theory was first clearly exposed by Haffer, 1969 (Haffer, 1982: 10-3; Prance, 1982b: 3).

6. As defined by Haffer (1982: 10) "a refuge is a comparatively restricted area where a particular biome such as a forest or savanna remained more or less constant during periods of vegetational shifts, thus preserving their mosaic for at least part of the forest's or savanna's animal and plant populations."

PART TWO

THE AMAZONIAN SOCIOSYSTEM: AN HISTORICAL APPROACH

CHAPTER IV

The First Centuries: An Economy Dominated by the Forest-Based Sector

IV.1 The European Arrival

In the 1400s, Portugal was a small Christian Kingdom on the western slopes of the Iberian Peninsula with little chances of territorial expansion. The Portuguese were, however, pioneers and increasingly becoming a power in sea navigation when most other Europeans still believed the Atlantic to be the edge of the world. In the late 1400s, they were using this sea power to serve the glory of God and the Portuguese King, as well as to enrich the rising class of merchants in Lisbon. Before 1460, they were already traveling to various islands and to the African coast as far as Guinea and substantial profits were being obtained in the trade of ivory, gold, and slaves. Soon after they had passed the Equator barrier better enabling them to pursue their ultimate goal: to find a sea route to the profitable spices of the ancient east breaking the Italian domination of this commerce.

According to medieval practice, Portugal tried to obtain monopoly power over the new discoveries. For this, it seeked papal sanction, which was an important arbitration resort for the case when

the monopoly could not be defended by force. Spain, also an Iberian Christian Kingdom, was the only European power at the time in condition to challenge Portugal's assertion of hegemony over the lands and water of the Atlantic and African shores, and so it did. After a short war, these two Iberian powers reached an accord whereby Portugal gave absolute control over the Canary Islands to Spain and for that it obtained Spanish recognition of Portugal's exclusive rights to govern other islands and to explore and conquer Southward along the African coast. This aggreement, giving virtual control of the Atlantic ocean to Portugal, was endorsed by the Pope two years later and became known as the 1481 Treaty of Alcaçovas.

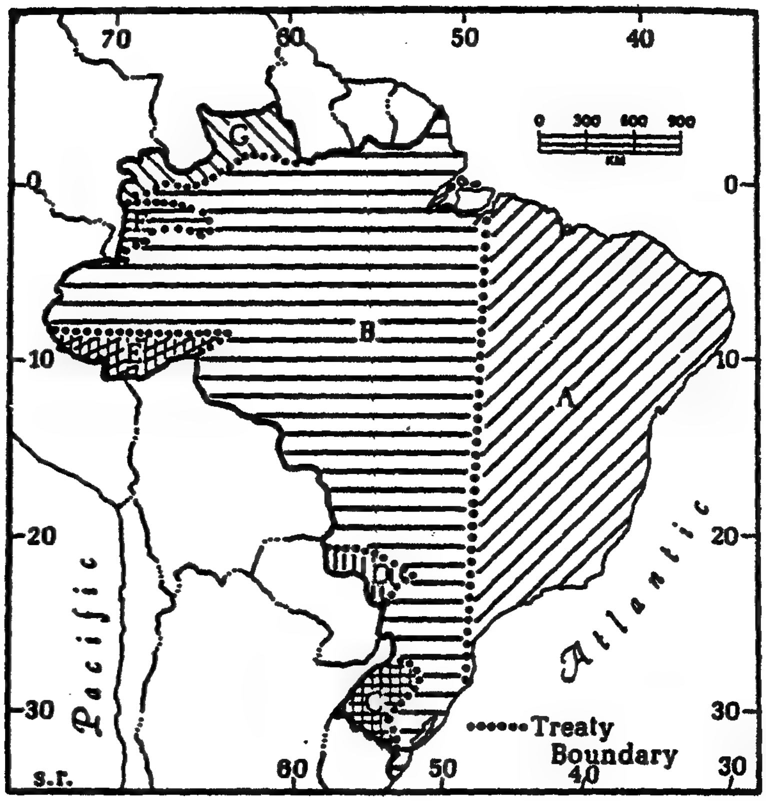
The famous discovery made by the Genoese navigator Christopher Columbus in the name of Spain in 1492 changed the scene. While the Portuguese were still surprised with this new adventure, Spain immediately appealed to Pope Alexander VI, a Spaniard, for papal recognition of its claims to the Indies and its sole right to seek Cathay and the spice islands by the western route. The pope favorably took cognizance of Spain's new discoveries, but in an attempt to minimize conflict between the two Iberian Kingdoms, he decided to divide the new regions between them. The initial papal proposal divided the unknown new regions by an imaginary line running from pole to pole--100 leagues west of Azores and the Cape Verde Islands. To the west of this line Spain should have complete control over the territories discovered and to be discovered, while Portugal would have control to the east. This arrangement was unacceptable to Portugal

which at that time had not yet rounded Africa and therefore did not know where it might fall. After threatening war, new negotiations were undertaken which resulted in a shift of the pole-to-pole line 270 leagues further to the west and in a new reference starting point: the Cape Verde Islands. This arrangement was signed at the city Tordesillas in June 7, 1494 and therefore became known as the Treaty of Tordesillas[1].

This Treaty turned out to be tremendously important for the future developments to occur in South America, Brazil, and Amazonia. It therefore pays to examine more throughly its terms. Due to the various limitations of epoch and imprecise language, the treaty generated confusion, uncertainty, and hence debate between the courts of Spain and Portugal for centuries thereafter as to the actual location of the line. The treaty did not pinpoint exactly which of the Cape Verde Islands were to be used as the base for the measurement, nor did it specify the length of the league to be used. The consequence was that interpretations of the location of the line in South America would range greatly from the Spanish extreme of a line running from Bahia to Ceará--i.e., only the easternmost tip of Brazil would be Portuguese--to Lisbon's position that the line should go from Patagonea to the Orinoco (Breymann, 1950 : 6-7; Poppino, 1968; Tambs, 1974 : 62). Most scholars have agreed on a compromise which places the line running from São Paulo to Belém as shown in figure 32 (Tambs, 1974: 62). But in 1494, the Treaty of Tordesillas was acceptable to all parties.

Portugal continued its search southward for a way to the east.

Figure32 : Composite Expantion Map of Brazil.



▨	A	-	TREATY of TORDESILLAS, 1494
▤	B	-	TREATY of MADRID, 1750
▦	C	-	TREATY of Ildefonso, 1777
▥	D	-	TREATY of 1872 with Paraguay
▩	E	-	TREATY of Petrópolis, 1903
▤	F	-	TREATY with Ecuador, 1904
▧	G	-	TREATIES with Venezuela & Colombia, 1905 & 1907

Source: Adapted from Tambs (1974).

In 1498, when Columbus was exploring the Caribbean for the elusive shores of Cathay, the Portuguese Vasco de Gama, led a fleet of three ships around the Cape of Good Hope to Calicut and successfully returned to Lisbon with enough spices to pay for several expeditions. In the next century, Portugal obtained and defended a vast empire in Asia and Africa (Poppino, 1968: 42). The discovery of Brazil and of the Amazon River were essentially accidents on this search for the east by both Iberian Kingdoms.

The Discovery of the Amazon River and of Brazil

Although there are several instances of explorations reaching the Amazon River mouth in the late 1400s (Goodland & Irwin, 1975 : 14-5, 20), it was only in February 1500 that Vicente Yanez Pinzon actually took greater notice of the river. Pinzon was a Spanish captian who had participated 7 years earlier in Columbus's first voyage to America. His expedition had set sail to the New World and in January 1500 it arrived at the coast of Brazil. After taking possession of the land for Spain, Pinzon navegated north and west until he became astonished to find that he was sailing through fresh water, despite the fact that he was well out of land sight. He decided then to look for the river. He found it, took possession of it for Spain, and impressed by the size of the water body he named the river Santa Maria de la Mar Dulce--later known simply as La Mar Dulce (The Freshwater Sea). He then went up the river's mouth for thirty of forty leagues. There he found the numerous Indian tribes inhabiting the banks of the river discussed

above. Unlike the other natives he had previously found in Brazil, these were friendly. Despite this, Pinzon took thirty-six of them aboard his ship as slaves, thereby starting a process that a century later would be fundamental for the colonization of the area. He then continued his trip up and north and finally back to Spain (Breymann, 1950: 2-4; Furneaux, 1969: 4-5; Goodland & Irwin, 1975).

On April 21, 1500, Pedro Alvarez Cabral, a Portuguese captain commanding a thirteen ship fleet--one of the largest expeditions Portugal had mounted to that date--apparently by accident discovered Brazil. The fleet was in route to India to secure for Portugal the prizes found by earlier explorers, but for poor navigation conditions they ended up landing on the Brazilian Coast around modern Bahia State. Thinking he had found an island, he called the area Ilha de Vera Cruz. After finding a better place for his fleet, he stayed for 9 days to make small repairs and refill water supplies. There they met Indians who seemed peaceful innocent pagans but no evidence of spices or precious metals was found. Pero Vaz de Caminha, the scriber, wrote a detailed report which was sent back to Lisbon by one of the vessels. Cabral left in the land two exiles to learn the native language and went on to find his way to India. Cabral is honoured in Brazil as its discoverer (Poppino, 1968: 45-6; Goodland & Irvin, 1975: 14-5).

Royal expeditions were sent out in the next years to explore the new land. They confirmed earlier reports of absence of precious minerals, but this time they found a valuable dyewood, the Brazilwood which later was explored by private merchants. Brazilwood, from which

the country obtained its name, was highly valued in the European textile industry as a source of red dye. Soon a profitable trade with the local natives, who performed entirely the heavy labor of preparing Brazilwood logs for shipment, was established. Other items were also exchanged with the Portuguese such as cotton, wild pepper, animal skins, parrots, and occasionally slaves; but Brazilwood was the most important (Poppino, 1969: 46-7, 115).

The Brazilwood trade did not go without notice by other European nations. France, which did not recognize the papal authority to divide the New World exclusively between Portugal and Spain, was especially active in the first century of Brazilian history. The Dutch and the English, which had similar attitudes toward the New World, soon were also active in Brazil. These pressures forced Portugal to adopt measures to guarantee possession of the land. Unlike Spain, which found unprecedent quantities of silver and gold with the Indian civilizations in Mexico and Peru, Portugal had to occupy its new lands via a system of Brazilwood trading posts.

The first decades of the colony were dominated by efforts by Lisbon to sweep the French "pirates" and later other Europeans too. These efforts had high opportunity cost since it diverted resources from the more profitable Orient trade activities. However, the belief of the existence of gold in the Brazilian interior, like the Spanish had found in other areas of America, led the Portuguese to invest in the protection of the colony (Poppino, 1968: 4, 47-9; Furtado, 1969: 6-7).

When the Brazilwood trading posts system was unable to achieve the goal of security for the coast line, the Portuguese crown decided to adopt a different strategy. King João III, after a successful experience with Martin Afonso de Souza beginning in late 1530, decided to employ a method of colonization which had also been successfully used in the Atlantic Islands during the fifteenth century. It consisted of dividing Brazil into several colonies united only by their common but independent ties with the Crown. Fifteen huge colonies were created and granted by the Crown to 12 distinguished and trustable individuals as hereditary captaincies. Each donatary agreed to defend, colonize, and develop his captaincy at his own expense, therefore saving the Crown many outlays and yet accomplishing the task of occupying its claims in the region. Since Brazil had no mineral riches, the donatories would have to create profit by themselves and agriculture was seen as the way to accomplish it since the Portuguese Crown reserved for itself the Brazilwood monopoly. Cattle and sugarcane were introduced by Souza.

In the north, three of the fifteen captancies corresponded roughly to modern states of Ceará, Piauí, Maranhão, and Pará. They were given to four donataries of which only one showed no interest in the adventure. The other three organized a joint expedition led by one of them and which set out for the region in 1535. But this effort was met by disaster and Aires da Cunha, the donatary leader, and the rest of the expedition members presumably lost their lives. The other donataries made no other efforts to colonize the Amazon Region.

Similarly, all other captaincies were unsuccessful except by two--São Vicente in modern São Paulo state and Pernambuco. After almost two decades, the Crown had not reached its goals for the region and was forced to pursue a new strategy. It was decided to create a central colonial administration for Brazil and the first Governor-general of the colony, Tome de Souza, arrived there in 1549 (Poppino, 1968: 48-52; Keimen, 1954: 8; Furtado, 1969: 7-10; Breymann, 1950: 64-6).

El Dorado and La Canela

While the Portuguese were busy concerned with French penetration on the east coast of Brazil, the first attempts to explore the Amazon Region were being made. It is to the Spanish conquistadores that credit should be given for these first invasions into the region. As discussed, the Spaniard in their explorations of the New World, found in Mexico and Peru advanced Indian population. In the land of the Mayas and Incas, they found richness in precious metals. The very advent of these discoveries in an unknown continent, combined with reports from various sources and with the fertile imagination of these early European explorers, led to the development of several legends. Myths such as that of the El Dorado and La Canela are prime examples. Historians consider these legends important magnets which pulled the first Spanish Conquistadors into the unknown interior behind the Andes. La Canela was said to be an area of the Amazon region where cinnamon trees abounded--at that time, this spice was a very profitable commodity. El Dorado--The Golden Man--is the legend of a kingdom so

rich that temples, palaces, street pavements, everything was made out of gold. The king of this land was said to wear only a fine coating of gold powder fixed to his body by a sweet smelling resin. Every afternoon, El Dorado would wash off in a lake and a new gold coating would be applied on him the next morning.

These legends were flexible and evolved to adapt to information obtained from new discoveries. For instance, initially El Dorado was said to be located in the area of modern Colombia and Venezuela. After several unsuccessful expeditions to find the kingdom, the legend evolved and the new location for it was said to be in the valley of the Amazon, west of the Rio Negro (Reis, 1931; Breymann, 1950: 23-9; Reis, 1965: 25-6; Furneaux, 1969: 12-8).

The Pizarro-Orellana Expedition

It was after the myths of La Canela and El Dorado that the Pizarro-Orellana expedition was organized and which ended with the first one way trip through the Amazon--then the Maranon--River. In the first decades of Spanish conquest of Peru, some expeditions were sent to explore the region. Information "confirming" the existence of La Canela and El Dorado were accumulating. In 1539, the greatest of these journeys was promoted by Francisco Pizarro, the conqueror of Peru, who entrusted the command of the <u>entrada</u> to his brother, Gonzalo Pizarro. This was a major expedition and attracted many wishing to participate in it. One of those was Francisco de Orellana, captain and Lieutenant-governor of the city of Santiago do Guayaquil, and a

relative of the Pizarro's.

In early 1540, this great expedition[2] got underway from Quito in modern Equator, but it was destined to face many difficulties. By the first barrier--the Andean Cordellera--many Indians died of cold in the snowy mountains and the difficulties of crossing forced the party to leave behind many of their provisions. They finally arrived at La Canela, which turned out to be disappointing in terms of its economic potential[3]. Orellana, who had left Quito after the main expedition, caught up and was appointed Lieutenant-general by Gonzalo Pizarro. After the initial disappointment of La Canela, Pizarro and his party, believing in the existence of rich lands ahead, questioned the Indians found in the area about the lands ahead. The Indians initially denied the existence of such lands, but after tortured for the "truth", they confirmed anything the Spaniards wanted them to. The party then went on now in search of the El Dorado.

After many difficulties in the travel in the thick and wet evergreen rainforests of the area (as discussed in part one), they were desperately close to starvation. The expedition then met several Indian groups who indicated that a well supplied land with provisions, gold, and other of the expedition's needs was to be found further ahead where the Coca River met a larger one. The party was traveling along the Coca River--an affluent of the Napo River--both by land and by a brigantine which they had built with great difficulty. Pizarro attempted to confirm the information given by the Indians by sending Orellana in the brigantine in search of the richer lands. Since

Orellana never returned to report to Pizarro on what he had found, this part of the expedition's history is controversial[4]. The result was that Orellana went on to be the first European to travel the Amazon River from the west until its mouth in the Atlantic.

Orellana left the main expedition in the brigantine and took with him a total of 57 men including Gaspar de Carvajal, a Dominican Friar-chaplain who was the only one to report their adventure. The brigantine went down the fast current of the Coca and some days later they arrived to the confluence with a larger river. They did not find the supplies or other riches the Indians had promised and then decided to continue down river in order to reach the ocean. During the next six months they were frequently attacked by Indians. Other times they invaded villages to obtain food, and in other instances they were friendly received by the natives. They killed, died, suffered hunger, insect bites, and were frequently subjected to heavy rainstorms. They had descended the Napo and Marañon Rivers and were travelling in the Solimões when the party met the junction of this river with a black-water river. They named it Rio Negro. Twenty days later, after travelling almost two thirds of the river's course, they met with women warriors whom they readily associated with the old fable and called them Amazons[5]. The importance of that encounter for that time was such that the river they were travelling, instead of its earlier Marañon name, became later known as the River of the Amazons[6].

In late 1542, they reached the river's mouth and from there they set sail to the north. Orellana finally made his way back to

Spain[7] where he was cooly received by the Crown which already had been informed of the events by Pizarro[8]. He had long explanations to give to the Crown, which was amused by his apparent disloyalty to Pizarro. Therefore, the plans he made to return to the area--New Andaluzia, as it became known--as governor, suffered a temporary set-back. But since he was the most qualified man in Europe and since Portugal and France had already shown active interest in the Amazon valley, his plea was finally appproved in February of 1544. However, due to several financial and other obstacles--the Spanish Crown refused to support him financially--Orellana would leave Spain only in May 1545 and even then illegally. He had not been allowed to leave the port because his fleet was considered unprepared for the trip.

After many difficulties including desertions, loss of lives, and loss of ships, he finally arrived in Brazil in December of that year. But these were only the first of the many problems faced by Orellana. After many months of searching for the main branch of the Amazon River, and with further ship losses--victims of the Pororoca phenomenon--and problems with the Indians, Orellana became ill and finally died in November of 1545 and was buried on the banks of the river he had been the first to navigate in its entirety (Breymann, 1950; Furneaux, 1969; Simonsen, 1969; Reis, 1965).

The Aguirre Episode

During the next year, other smaller trans-Andean penetration in Amazonia occured, still attracted by the same desires for gold and other

riches. Colonization schemes were proposed and some were carried out. But none of those activities went any closer to repeating Orellana's adventure. In addition, many other efforts for the creation of entradas were blocked by the Spanish Crown. That was because, as far as the Crown was concerned, these expeditions did not accomplish anything besides diverting men and other resources from more profitable tasks in Peru and Chile. A few years later, however, Peru was in anarchy with thousands of individuals attracted by the news of riches, creating all sorts of problems for the Viceroy. The new administration of Marquis of Canete saw the reopening of the entradas as a means to aleviate the Peruvian anarchy.

The most important of the several expeditions undertaken in this period was the one led by Pedro de Ursua, which started in late 1560. In this expedition, many trouble makers took part, including Lope de Aquirre, a notorious conspirator. He and his followers carried out various activities to undermine Ursua's leadership, which ended up with the murder of the official leader. Ursua was replaced by Fernando de Guzman, but only as a figurehead. Aguirre finally revealed his final plans to overthrow the Spanish government in Peru by armed rebellion and possess the riches of the land. By a reign of terror, Aguirre and his followers impossed their views over the rest of the expedition. Still trying to keep a low profile, he had Guzman elected "Prince and King of all Tierra Firma." Shortly after the new Prince had also been killed. Aquirre and his maranones, as they chose to call themselves, continued the journey now in an effort to get to the sea in order to

continue their plans. After much fight and destruction, Aguirre was finally killed by the Crown forces in one of the Carribean islands.

Unlike Orellana's voyage, little record was kept of the Aguirre episode and his contribution to the knowledge about Amazonia was small. Even the very fact of whether or not he travelled through the Amazon River has been debated (Breymann, 1950: 90-134; Furneaux, 1969: 42-53).

This episode, however, induced king Philip II in 1563 to reverse his exploration policy and decide that only special request of expeditions would be licensed by the authorities in Spain. But El Dorado was still a strong magnet and the number of entradas did not decline substantially. Instead of being expeditions of conquest, the new entradas were said to be of colonization, pacification, and development of the areas already explored--which required only the license from the local authorities in Peru. Many indeed pursued the intended objective but others did not. In addition, expeditions were also being undertaken from the coast of Venezuela. Some of them involved not only Spaniards, but also German explorers. Since 1528, the Germans received extensive rights to the western parts of Venezuela, and they were mostly concerned with capturing slaves and searching for El Dorado.

Conquer of Souls

These entradas suffered the same problems of desertions, mutinies, Indian attacks, and diseases faced by the earlier expeditions, but none had the same impact on the knowledge about

Amazonia as did Orellana's, nor did they try to repeat his adventure. After Aguirre's fiasco, it took almost three-forths of a century before another European would descend the Amazon River to its mouth. This time it was not the Conquistador who performed the achievement, but rather it was the missionaries (Breymann, 1950: 135-145; Furneaux, 1969: 48).

By late XVI century, a new type of entrada was being promoted and even financed by the Spanish Crown. They were organized by the Spanish missionaries--mostly Franciscans and Jesuits--in order to pursue their conquista das almas--conquer of souls. Their role was to save the thousands of pagan souls found on the Amazon and bring the Indians under the influence of the church. The concrete thought of so many infidels wandering in the vast forests had a magnetic effect over the missionaries as strong as El Dorado had had over the conquistadors. During the first decades, the missionaries concentrated purely on the headwater in the cordillera, working with tribes already visited and relatively better accessible. In the second half of the XVII century they shifted their attention to the riverine interior, but because of lack of appropriate support, they did not accomplish much (Breymann, 1950: 149,64; Furneaux, 1969: 67, 74).

Expulsion of Amazon Invaders

During the period of 1580 to 1640, Portugal fell under Spanish rule--a period which became known as the "Babylonian Captivity." During this period, there was little competition between the two

Iberian nations. Their separate colonies continued to be administered as before, keeping their respective language and laws, but restrictions against travel and trade between them was not rigidly or consistently enforced. During this period, Portugal was responsible for the defense of South America from the Amazon River's mouth southward, against the Dutch, English, Irish, and French. As will be seen below, it was during this period that Portugal dominated the mouth of the Amazon and took the first and decisive steps to control the region (Breymann, 1950: 165,181; Furtado 1969: 72; Poppino, 1969: 69-71; Furneaux, 1969: 48).

But by the end of the sixteenth century and early seventeenth century, the French and other Europeans were becoming very active in the Amazon region. They first arrived with the objective of exchanging with the Indians, but soon they started also creating settlements of their own. From their bases in the New World they also conducted piracy assalts on the Spanish ships. In 1599, the Dutch, considered to be one of the first of the other Europeans to settle in Amazonia, established without major problems two forts at the mouth of the Xingú River--Orange and Nassau. In 1604 an English colony was established on the Oiapoque River, some 400 miles north of the Amazon River's mouth. At the same time, the French were exploring the coasts of the Guianas. During the first years of the 1610s, the English sailed some 200 miles up the Amazon and founded colonies on its mouth.

In 1612, the French ambition was such that the Queen-Regent had authorized the foundation of a colony south of the Equator. They named

their new colony Saint Louis, a starting point to realize the dream of an Equinoctial France in northern Brazil.

The Portuguese, as seen above, had not been active in the Amazon region. In 1613 however, a _bandeira_ lead by Pero Domingues had reached Amazonia by land. The party with thirty Portuguese and some Indians had reached an affluent of the Araguaia River where they built some canoes and descended to the mouth of the Tocantins River. They had contacted Frenchmen in the Rio Tocantins who were trading with the natives.

With the increase of reports of the presence of so many foreigners in the north and the realization of the risks of losses of the possibly rich lands, the Portuguese finally acted. They acted because, under the domination of Spain during the Babylonian Captivity, they were given the responsibility to defend the American lands southwards from the mouth of the Amazon. In 1615, a strong expedition led by Jeronimo de Alberquerque was able to dominate Saint Louis and convert it into the Portuguese town of São Luiz—currently the capital of modern Maranhão state. From there they sent Francisco Caldeira de Castelo Branco to drive out the other foreigners and to secure the entrance of the river against other intrusions. For that, Castelo Branco founded in January, 1616, on the outfall of the Rio Tocantins, the settlement Nossa Senhora do Belém—the capital of modern Pará state—in the estuary known at the time as Grão-Pará (big water)[9]. From there the Portuguese and their Indian allies started the expulsion of the foreigners; an operation which lasted more than two decades.

Therefore, it was by defending the lands of Spain for the Luso-Spanish reign that Portugal obtained a key position on the mouth of the Amazon River. During this period, the name of Pedro Texeira started to appear in the history of Amazonia, at this time as the most successful military leader against the foreign invadors (Breymann, 1950: 64-6, 165-198; Kiemen, 1954: 10-8; Simonsen, 1969: 307; Furtado, 1969: 72; Furneaux, 1969: 48-53; Tambs, 1974: 61).

Breymann (1950: 180) has suggested that one of the reasons for the delayed Portuguese interest in the north was the fact that it was very difficult to sail in the northern coast of Brazil due to unfavorable winds and ocean currents. Indeed, it was much easier to navigate from the Amazon Region to Lisbon than from the Amazon Region to the Brazilian east coast. Although initially the region's original administrative organization as captancies of the state of Brazil was still valid, the communication difficulties led to the creation in 1621 of a separate colony directly subordinated to Lisbon. The new State of Maranhão and Grão-Pará, which comprised roughly from the modern state of Ceará to the Amazon Region, was administrated by a Governor-general, initially located in São Luiz, and was completely independent from the Viceroy of the state of Brazil[10]. But it was only in 1623, that the new Governor-general, Francisco Coelho do Carvalho, arrived in the new state. The state of Maranhão and Grão-Pará existed until 1775 when it was reintegrated to the state of Brazil (Breymann,1950: 177n, 180; Kiemen, 1954: 3, 26-7; Prado Jr. 1967: 70; Boxer, 1962: 273-5; Simonsen, 1969: 308; Furtado, 1969: 73n).

IV.2 The Colonial Period: Indians and Forest Products

The first years of Portuguese presence in the Brazilian north were difficult and unstable ones. They had arrived in an area inhabitated by Indians and invaded by foreigners whom they were supposed to expulse. They were in relatively few numbers and had several tasks of establishing the basic infrastructure of a fort and later of a city and also of fighting war against the Europeans and their Indian allies and other Indians. In 1619, for instance, a massive attack by Indians resulted in large destruction and death. Like the other foreigners in the region and accordingly with their experiences in other areas of the colony, the Portuguese recruited thousands of Indians to fight those wars.

As discussed in section III.2, the Pre-Columbian Indian population in Amazonia was large and for a great extent, was living harmoniously in its environment. The passage of the first Spanish explorers during the XVI century had not affected them substantially. Later in that century, the Dutch, French, and English started arriving in the upper Amazon River area and their lifestyle and numbers were about to change dramatically. With the arrival of the Portuguese determined to expulse the other Europeans from Luso-Spanish lands, warfare intensified. The Indians died fighting for their land against the white invaders. They died fighting for their European allies against other Europeans and their Indian allies. They were captured many times as slaves and often died due to overwork and harsh

treatment. They also died from diseases that the Europeans brought with them and against which the Indians had no natural immunity[1].

The Indians in Amazonia during the first decades of the Portuguese presence in the region also became its most important export. The northeast of the state of Brazil during that period was one of the largest sugar producers in the world. The revenues from this production also helped Portugal to finance the expulsion of the foreigners from the lower Amazon. Sugar production in Brazil, using technology and equipment that the Portuguese already knew before the colony's discovery, needed large numbers of labor and the Indian population in the producing areas was already quite reduced. However, the export of Indian slaves to the sugar plantations of the northeast did not last long. The Dutch contest for possession of the northeast (1624-56) provoked a substantial reduction of this commerce after 1630s (Kiemen, 1954: 21-2; Boxer, 1962: 278-9; Simonsen, 1969: 308-9; Meggers, 1971: 150-1; Poppino, 1968: 71; Vianna, 1967a: 186-9; Furtado, 1969: 10-1, 14, 72; Gross, 1975: 221; Sioli, 1974).

Labor Scarcity and Indians: Missionaries Versus Colonists

Labor problems have always been central in Amazonia's history, but perhaps it was more critical in the first century. This situation was no different from the situation in other colonies in the New World. The immigration of large numbers of Portuguese was not possible because of its cost besides the fact that the Portuguese were also committed to trade and colonization efforts in other parts of Brazil and in Asia.

Besides, the Portuguese were generally unwilling or indolent to labor themselves prefering to rely on slaves for almost all tasks. The profitable sugar production which in other parts of Brazil financed the import of black slaves from Africa, was never very significant in Amazonia. These factors, combined with the existence of large Indian populations in the region, resulted in the natives to become the most important labor source in the region. This aspect of the Amazonian colonization as well as the operation of missionaries in the region are fundamental in the historic process of the region in its first centuries (Boxer, 1962: 277; Kiemen, 1954: x, 181; Gross, 1975: 211, 221; Furtado, 1969: 13; Furneaux, 1969: 62; MacLachlan, 1973: 199).

The Indians were fundamental for the Portuguese colonization enterprise in Amazonia. They had knowledge about the region and its resources and were utilized in various tasks. Initially they were utilized in rowing, fishing, hunting, manual labor, and most importantly, in the warfare against the European interlopers and other Indians. They were also employed as field hands and domestic servants for the colonists and for the public administrators. They were labor for the salt industry and also used in construction. Later in the XVII century they became very important in the expeditions which periodically went up the Amazon River and its tributaries to collect the drogas do sertão; a task which they were very good at (Kiemen, 1954: 181; Boxer, 1962: 278; MacLachlan, 1973: 207-8).

But for the missionaries, who first arrived in Pará in 1617, the Indians had the same appeal that they had for their Spanish counterparts

working with the Amerindians in the foothills of the Andean Cordillera. The Indians were seen by them as infidels who had to be converted to Christianity. The Crown looked upon them as an inferior race; child-like wards under its responsibility. At that time, missionaries were considered servants of the King as well as of the church, and the Crown determined that they would be entrusted with the conversion task. While black slavery was encouraged by the Portuguese Crown, Indian slavery was officially prohibited in 1570, although loopholes could be found. But Lisbon, with the constant remainders from the colonists, also knew the importance of the Indians as labor force. This fundamental dilemma of the Portuguese Crown led to the creation over the years of Indian policies and legislation which moved from the missionary's viewpoint of the natives as free men to the colonist's viewpoint as labor sources--preferably as slaves. The different positions that colonists and missionaries had were also the source of frequent conflict between them (Breymann, 1950: 180-1; Kiemen, 1954; MacLachlan, 1973; Poppino, 1968: 59; Gross, 1975: 218).

Since the Portuguese were small in number, they could not easily. promote large-scale expansion into the interior. To satisfy their constant needs for Indians, in the initial years of the Portuguese occupation in Amazonian. They devised a system which was different from what was usually applied in other regions. Instead of pushing the Indian population further and further into the interior so that they could take over Indian land, the Portuguese actually sought to bring the natives closer to their settlements. When the Portuguese arrived in

Amazonia, they started the creation of a system of Indian villages, aldeias, in which Indians were encouraged or forced to live. From there the Europeans could easily obtain their labor as needed. With the reduction of the Indian numbers by death or desertion, as discussed above, and with the increases in labor demand; Indians to populate the villages were obtained by the entradas further and further from the coast. From the beginning, the missionaries understood that thoir success in Christianizing the pagan Indians would depend on how entradas and aldeias were to operate.

When the first Franciscans arrived in Pará in 1617, they followed the creation of aldeias, according to a 1611 law, under the control of lay captains. The same law also allowed the existence of tropas de resgates--expeditions sent to "rescue" Indians who had been captured by their Indian enemies and who were kept as priviledged slaves until they were finally sacrificed in cerimonial canibalistic acts. The Indians "saved" by those expedition were obligated to serve their savers for 10 years if the colonists paid them the government estipulated minimum wage, or more years if the Indians were paid better. All economic (exchange) transactions in Amazonia, even well into the XVIII century were made in kind. The Franciscans did not like what they had seen and in 1624 a large contingent of Franciscan missionaries arrived in the region with a mandate to take over the administration of Indian affairs in the state and to abolish the lay captain control of Indian villages. In the new system, the Franciscans would live with or visit the Indians frequently in their villages in

order to Europeanize and convert them to Christianity. As one can expect, the new system found problems from the beginning. Although in Maranhão the law was reluctently observed, in Pará it was completely rejected. The Franciscans had other troubles, including financial ones--which was part of their principles--and which finally resulted in their desistance after 1630. The old layman system then returned and operated until 1652 when a new missionary Order, the Society of Jesus, took over the official control of Indian affairs (Kiemen, 1954: 7, 29-47, 181-3, 188; Simonsen, 1969: 314).

Pedro Teixeira, Antonio Rapaso de Tavares and
the Portuguese Westward Expansion

Before going any further with the discussion of the Jesuit experience with the Indians in Amazonia, it is important to refer to two basic events that occured during these early years. The first relates to the idea which had existed since the 1530s of transforming the Amazon River in a transportation route. During the Babylonian Period this idea was brought again to the Spanish Crown as a way to overcome the problems with pirates in the Caribbean area. But the thought of having Spanish gold and silver rich ships moving in a river whose mouth was controlled by the Portuguese somehow did not seem to have appeal to the Spanish Crown. Hence the route was never developed.

In late 1630, a new event occurred. In 1636, thirty Spanish soldiers and a few Franciscan Friars were attacked by Indians in a town that the soldiers had recently established on their land. Some died,

many escaped back to Quitos, but 2 friars--Domingo Brieva and Andres de Toledo--and six soldiers resolved to escape from the Indians by fleeing down the river. Among the soldiers was a Portuguese one who helped to persuade the group to go down to the sea through the little-known rivers. The group so decided and with the use of a simple canoe and a few provisions, they left. Unlike the earlier entradas of Pizarro--Orellana and Ursua-Aquire, the small and poorly prepared group reported no major problems during their amazing adventure. They supplied their needs from the forests and after only four months they arrived at the Portuguese fort of Gurupá in February 1637, completing the third trip from the Andes down the Amazon River and the first in more than three-fourths of a century. The group was later brought to the presence of Governor Jacome Raymundo de Noronha who was very impressed by their miraculous trip. Norenha, based on earlier recommendation from Philip IV to explore the inland navigation between Brazil and Peru and on the success of the Spanish group, determined that Pedro Teixeira form an expedition to ascend the river up to Quito. Philip IV had also in that year of 1637 during the Babylonian Captivity period, decided to give legal title to Portugal of parts of the lower Amazon. He created two Capitanias in that area and gave them to Portuguese nobles, thereby opening up the Amazon Region to Lusitanian occupation.

Pedro Teixeira, the successful military leader of the European intruders expulsion period, left the lower Amazon six months later with a party consisting of 47 large canoes, 70 soldiers, 1,200 Indians, and

some Friars. Among the missionaries was Domingo Brieva who was to return to Quito as a guide for the expedition. The size of the group was its guarantee against possible Indian attacks. After almost nine months travelling through the Amazon, Solimões, Marañon, and Napo Rivers, the party finally arrived at the town from which Brieva and his friends had fleed. From there Teixeira went with a small group to Quito. The unannounced arrival of such a large Portuguese expedition at the Andes foothills was very surprising for the Spanish administrators in that city. The idea of a Portuguese revolt against Spanish domination in Europe was not completely out of question--as indeed it happened two years later. This led the Spanish to be suspicious of the Portuguese party's objectives. The administrators reasoned that such a large group would certainly be needed in the Amazon River mouth region, hence, Teixeira was sent back the same way he came. They also decided to include in Teixeira's party two Spanish Jesuits, Cristoval de Acuña and Andres de Artieda, as official observers and who were to proceed from Belém to Spain with a full report of the travel. The Franciscan Brieva also returned to Pará with Teixeira. They left Quito on February 1639 and arrived in Pará in December 1639, completing the first round trip of a Portuguese party on the river. Acuña made a report of the trip and became the first to produce a detailed, careful and well-considered description of a travel on the Amazon River.

Among other interesting observations, Acuña reported Portuguese slaving expedition operating as far as the Tocantins River. But the

fact of greatest importance of this return trip was not reported by Acuna. On the junction of the Napo and Aquarico Rivers (the eastmost point of modern Ecuador), Teixeira solemnly placed a marker and claimed in the name of Philip IV, King of Spain (Philip III of Portugal) all the lands east of that point. As will be seen later, this fact was fundamental in the negations of a new Treaty in 1750 to replace the Treaty of Tordesillas.

Acuna did, however, warn the Spanish Crown of what happened. So did Peruvian administrators, but the barriers offered by the Andes Cordellera and the problems with natives made the Spanish advance on the region very difficult. The Crown, therefore, left for the unarmed and unaided Spanish Jesuits the task of occupying the region (Breymann, 1950: 199-226; Poppino, 1968: 92; Furneaux, 1969: 53; Simonsen, 1969: 304; Tambs, 1974: 63-4; Vianna, 1967a: 189, 90).

The other event of importance that occured during this first half of the XVII century was the <u>bandeira</u> of Antonio Raposo Tavares. Between 1648 and 1651 his party, comprised of 200 <u>Paulistas</u> and 1,000 armed Indians, moved westward from São Paulo, reached Rio Grande in Bolivia, and from there descended through the Madeira and Amazon Rivers up to Belém. By doing so, this bandeira, which has been considered the greatest of all bandeiras, linked São Paulo with Amazonia. This bandeira combined with the operation of the Madeira-Mamoré-Guaporé route to Belém and from there to Lisbon, were later going to reinforce Portuguese claims over that region[2] (Poppino, 1968: 82,4; Tambs, 1974: 63-4; Davidson, 1970).

The *Regimento das Missões*

Back to the discussion of the dominant issue of this period in Portuguese Amazonia: the labor force. As previously noted, in 1652 the Jesuits, under the leadership of Friar Antonio Vieira, were put in control of the Indian villages. Fr. Vieira was very influential over the Portuguese King and he used this to obtain arrangements to avoid one of the basic problems faced earlier by the Franciscans--the lack of financial security. Among these arrangements was included a royal salary for the Jesuits. Besides, Vieira made sure that the Jesuits would have control over the mission villages as well as control of the entradas used to obtain more natives up river. However, not even Vieira's influence in the court would diminish the problems faced by missionaries with the settlers. In 1661, a short-lived revolt and expulsion of the Jesuits from both Maranhão and Pará was sufficient to make Lisbon to reinstate the system of lay control in 1663. The missionaries--Jesuits and others--were then restricted to providing spiritual help to the oppressed natives. Once again under the old system, the aldeias suffered many problems with dissertions and difficulties with bringing Indians from farther and farther distances. In 1664, for instance, expeditions to capture the Aboriginals were already reaching the Rio Negro.

But in 1680, Vieira and the Society of Jesus saw the reestablishment of their temporal power over the Indians, this time also including power over distribution of the labor to the colonists.

The hand of the Jesuits was strengthened even more when the Lisbon government, in response to the 1684 revolt in Maranhão--mainly against a commercial company set up in 1682 but which also resulted in the expulsion of the Jesuits from that part of the state--reacted negatively to the colonists demands. The regimento dos missões of 1686 was then established as a new set of laws that gave complete control of the Indians to missionaries, although the Crown did not put aside the interest of the local government and of the settlers. This time, however, the Jesuits would have to share the control of the Indian villages with the Franciscans of St. Antony who were to be the only whites allowed to live in their respective aldeias. In 1693 and later, other missionary orders were also allocated specific areas of the Amazon region to work with.

Tropas de Resgates and entradas strictly supervised by the missionaries were also allowed by this regimento to satisfy labor demands, but the distribution of the Indians so captured was still under the supervision of the missionaries. Privately financed resettlement of "uncivilized" Indians was allowed later. The wage rate of the Indian workers, who could not be forced to work for more than six months each year, was also strictly regulated. The regimento suffered several minor adjustments over the years, but the aspect of temporal and spiritual control over the Amerindians was kept. Upon the same labor pool, missionaries, local government, and many colonists depended. But it seems that the missionaries and the goverment were the basic beneficiaries from the regimento mission system (Kiemen,

1954: 176-80, 183-5; Boxer, 1962: 279; Simonsen, 1963: 312-324; Furneaux, 1969: 66; Meggers, 1971: 150-1; MacLachlan, 1973: 200-8; Gross, 1975: 216).

Forest Products Economy

The first centuries of Amazonian economic history after the Portuguese arrival in the region were marked by poorness and difficulties. At the beginning they were concerned with the expulsion of the other European interlopers and with the production for local consumption, which was probably very small. As noted above, soon the export of Indian slaves to the sugar producing regions of the Northeast Brazil became the best economic activity in the lower Amazon and Sao Luis. This commerce prevailed until the end of the "Babylonian Captivity" period in 1640.

In these first decades, the region represented an economic burden to Portugal which itself had lost the best of its oriental entrepot. After obtaining its independence from Spain, Portugal's situation did not improve and the Amazon region initiated a period of substantial hardship. The Indian slave trade with the northeast was reduced due to the difficulties caused by the Dutch occupation of the sugar producing areas[3]. Effort to recuperate the northeast was one of principal priority for Portugal. In addition, Spain would not recognize Portugal's independence until almost a quarter of a century later, which left Lisbon in a delicate position in terms of its own defense. The combination of these factors led the recently created

state of Maranhão and Grão-Pará to pass through one of its most difficult moments[4].

There was no production of any goods which could be exported, which left the colony in a subsistence condition which was going to last almost until the turn of the 16th century. During this period, the role of the Indian as a labor source was increased since in this unspecilized society each of the few families existent in the region had to "provide for its own needs". That is, the Indians became fundamental to provide for the needs of each family. The agricultural production was low, and since land was abundant, it depended heavily on the availability of labor, Indian labor, which was not well suited to the production process known to the settlers at the time. Poorness and anarchy prevail in this period.

By the time the regimento das missões became law in the 1680s, the export of the so called drogas do sertão, or backland drugs, had initiated. These drugs were mostly spices, products of great economic importance for European societies in that period. Like the canela that Pizarro-Orellana's expedition looked for, they were forest products—e.g., cloves, wild cottons, vanilla, sarsaparilla, pepper, nuts, indigo, oleaginous seed, annatto fruit, exotic birds and animals, wood from various species, and in special cocoa[5]. An economy based on the collection of these forest products started to evolve[6]. Now the same Indian who had shown the Portuguese many of these spices of the new colony, became once again the basic component of its production. That is because besides being the major labor source, they

were well adapted to the task. The Indians knew how to survive in the forest and how to locate those drogas, in addition to being excellent with canoes. These were tasks that even if African slaves were available in quantity they would not be able to perform as well.

But the development of this forest product economy based on the work of the Indian and under the regulations of the regimento of 1686, proved to be damaging for the settlers and beneficial to the missionaries. The job of collecting those products inside the forests gave the Indians the opportunity to escape the Portuguese settlers' domination, especially for those who lived under the slave regime. Unlike the Indians working for the colonists, the Indians collecting spices for the missionaries were less inclined to escape and consequently the mission villages prospered during this period.

For the first time, economic production in Pará was superior to that of the rest of the state of Maranhão and Grão-Pará. São Luis could not exploit the forest products commerce as Belém could. Meanwhile, through the first half of the 18th century the situation of the colonists continued bad. Hence, their opposition against the missionaries grew. But Belém in general was better off, economically and politically, so much so that in 1737 the headquarters of the Maranhão and Grão-Pará State's administration was transferred from São Luiz to Belém (Boxer, 1962: 278,299; Prado Jr., 1967: 70-2; Poppino, 1968: 91; Simonsen, 1969: 308-10, 316-7, 324-6; Furtado, 1969: 36-7, 72-3; Gross, 1969: 269; Reis, 1974: 33-5; Viana, 1967a: 183).

Forest Products and Westward Expansion

It was during this period that the expansion westward from Pará increased. With the depletion of the forests around the closer rivers, there was the need to collect the forest products further and further up river. From the very beginning of the European domination of the Amazon Region, the large network of rivers had been fundamental for all activities. The rivers were like prolongation of the litoral and were navigated mostly up to the areas where the Guianan and Brazilian shields rock outcrops create rapids. In contrast, the tropical forest diminished the accessibility of the terra firma areas. The rivers were the only practical means of access and Portugal had its control by dominating the lower Amazon. Combined with the extractive nature of the collection of forest products and Indian resupplying expeditions[7], these factors resulted in the occupation of the region along the rivers in a linear fashion.

The claim made by Pedro Teixeira in 1639 was not upheld by the Portuguese. But after the main foreign interpolers were expulsed, the Lusitans were more active in establishing forts, missions, and trading posts in the Amazon and its main affluents. It seems that by late 1670s, the Portuguese erected in the area where the Solimões and Negro River meet, the Fortaleza de São José da Barra do Rio Negro--later to become the capital city of Amazonia state, Manaus. At the time it represented the extreme west permanent occupation point of Portugal. Besides being a support post for Portuguese travelers, it tried to prevent the Indian trade with the Dutch who operated in the area from

their bases to the north. Defense was always a concern of the Portuguese. In late 1690s, they established two new forts on the Amazon River: (1) the Fortaleza de Santarém, near the mouth of the Tapajós, and (2) the Forte d'Óbidos, a very strategic point since there the river channel is only 1,892 meters wide which facilitates control of navigation.

Unlike their Portuguese brothers, the Spanish missionaries faced more difficult geographic barriers and generally lower support from the Madrid government. The Spanish Crown was more concerned in exploiting the east richs of Peru and Mexico. But by the end of the seventeenth century, these missionaries were already feeling the pressures of the westward Portuguese advance in search of Indians. In response to the request of the Omagua Indians of the upper Amazon for the presence of Spanish missionaries in their area, a German (Bohemian) missionary working under the flag of Spain, Father Samuel Fritz was sent in 1686. The Omaguas were being frequently bothered by the Indian capturing expeditions and they believed that the presence of the missionaries would prevent it from reoccurring. Father Fritz did an outstanding job of creating missions along the Salimões in the areas of the large tribes of the Omaguas and of the Yarimagua. But in 1687, he was the victim of a disease which obligated him to look for civilized help in Belem, by going down river in a canoe. Fritz was kept in quaranteen and treated in Pará but his presence in the upper Amazon was seen by the Portuguese as an advance of the Spanish in Amazonia. Twice in the following decade, Spanish missionaries were advised by

Portuguese officials to withdraw. In 1710 the Lusitans employed force to expulse the missionaries and the Spanish military who tried to reinstate their domains, thereby ending Spanish efforts to hold the area (Kiemen, 1954: 180; Prado Jr., 1962: 70-1; Poppino, 1968: 90, 93; Furneaux, 1969: 67-70; Sweet, 1974; Tambs, 1974: 64, 66).

But Portuguese security problems were not limited to Spanish advances. In 1697, the French moved south from their colony at Cayenne--in modern French Guiana--and seized modern Amapá. The Lusitan reaction was strong and fast, obligating the French to withdraw.

During the last years of the century, Portuguese officials repeated acts of possession along the Amazon, Solimões, and their major tributaries, and on the North coast as far as the Oyapoque River.

The dispute between Portugal and France over modern Amapá was settled in 1713 by the Treaty of Utrecht. With the help of its ally and dominator, England*, the Portuguese obtained from France its recognition of Portugal's domination over the whole Amazon Basin. This Treaty became the first international document to give legitimacy to Portugal's occupation of Amazonia.

Treaty of Madrid and Uti Possiditis de Facto

The Madeira route from Mato Grosso to Belém, found by the bandeira of Antonio Raposo Tavares in late 1640s, remained little used until the 1720s. Then gold and diamonds were found in Mato Grosso and the Guaporé-Mamoré-Madeira route, which was 2,700 miles long, was established. Through the activities of this route, which was operative

for almost a century, the Portuguese occupied Soutwest Amazonia and Mato Grosso. In addition, the route created a greater contact between the two Portuguese colonies: Brazil and Maranhao and Grão-Pará. This greater contact combined with other communication routes through central Brazil established by bandeirantes, resulted in the official integration of two colonies later in 1775 under the common name of Brazil.

The several advances of the Portuguese flag to the west through the work of missionaries, military personnel, Indians, traders, and bandeirantes was greater and greater in these first centuries. This Portuguese occupation of Amazonia and west Brazil was officially illegal, but as we have seen with knowledge of and sometimes consent from the Spanish. This situation was remedied in January of 1750* when Portugal and Spain agreed to annul the 1494 Tordesillas Treaty and sign a new treaty in Madrid. Although apparently Spain lost through the Treaty of Madrid much of its territory, both nations had good reasons to reach the agreement.

> The Portuguese objectives in negotiating the Treaty of 1750 may be resumed as follows:
>
> (1) To strike a balance between the boundary claims of Spain and Portugal by allotting the greater part of the Amazon basin to the latter country and that of the Rio de La Plata to the former.
>
> (2) To secure the undisputed sovereignty of the gold and diamonds district for the Portuguese Crown.
>
> (3) To secure Brazil's frontier by the retention of the Rio Grande do Sul and the acquisition of the Spanish Jesuit mission area ("Seven People") on the left bank of the river Uruguay.
>
> (4) To secure the western frontier of Brazil and river communication with Maranhão-Pará by ensuring that navigation on the rivers Tocantins, Tapajós, and Madeira remained in Portuguese hands.

> On the Spanish side, the compelling motives seem to have been:
>
> (1) To stop the westward advance of the Portuguese, who had already encroached on much of what was theoretically Spanish territory even though it consisted mostly of virgin jungle.
>
> (2) To secure the colony of Sacramento, which functioned as a backdoor for the illegal Anglo-Portuguese trade with the Vice-royalty of Peru and which rendered Buenos Aires dangerously to foreign invation.
>
> (3) To undermine the Anglo-Portuguese alliance, and thus eventually to facilitate a union of the two Iberian powers in South America against English aggression and ambition (Boxer, 1962: 294-5).

It was through this treaty that the concept uti possidetis de facto (right of possession by occupation)--as opposed to uti possidetis de jure (right of possession by law)--was first introduced in order to determine the Spanish and Portuguese colonies boundaries. This concept has been fundamental to the settlement of boundaries in South America ever since.

Marquis of Pombal

With the death of Dom João V and the rise to power of the Marquis of Pombal in Portugal and the death of Fernand VI with Carlos III as his successor in Spain, the Madrid Treaty seemed to both nations as less acceptable. The 1750 Treaty was annulled and in its place a new Treaty of Pardo was signed in 1761 which called for a return to status quo. The concept of uti possidetis de facto clearly indicated to both nations that occupation of territory was fundamental for the definition of boundaries. But Portugal had at this point a much better position.

Marquis of Pombal officially opened the Madeira route in 1752

and later implemented a plan to establish several fortresses in key points in the upper Amazonia and Mato Grosso. These fortresses not only contained Spanish advance, but it also consisted in bases for Portuguese expansion. The Portuguese strategy was generally successful and in 1777, a new treaty between the two countries was established in San Ildefonso. This treaty was very similar to the Madrid Treaty and through it, as shown in figure 32, Brazil reached substantially its modern limits (Kieman, 1954: 180; Boxer, 1962: 293-6; Prado Jr., 1967: 446-7n; Poppino, 1968: 72, 93-4, 111-2; Furtado, 1969: 38-9; Simonsen, 1969: 330-1, 334-7; Furneaux, 1969: 72; Davidson, 1970; Viana, 1967a: 183; Tambs, 1974: 61, 65-9).

Unsuccessful Agriculture

The economy of Amazonia at the beginning of the XVIII century was dominated by the collection of drogas do sertão, but agricultural production also existed. In fact, agriculture was basic for the Portuguese mercantilist model--Amazonia as a supplier of valuable tropical products and a consumer of Portuguese exports. Lisbon throughout the years designed a development policy for the region which tried to repeat in Amazonia the success of the sugar enterprise in northeast Brazil. For this purpose, sugarcane was one of the first agriculture products that the colonists tried in the lower Amazon area. Tobacco, cotton and cassava, which were known to the natives, and rice were also planted. Coffee was first introduced in the Portuguese colonies of America later in the 1720s, brought from Cayenne. The

increasing success of the drogas do Sertão was in part due to the fact that the colonial governors sent many samples of native products to be appraised in Portugal. In return, Lisbon sent useful trees and bushes found in other parts of its domains to the governors so that they could be tried. Through these introduction practices were brought to Amazonia, for instance, cinnamon and pepper. Cattle had also been introduced early in the colony and, for instance, by the mid 1750s large herds (15,600 heads) were being raised by the Jesuits in the Maracu village on the Pindoré River in modern Maranhão state. It was also introduced in the Marajó Island.

But agriculture production in Amazonia was not as successful as Lisbon had expected. Even with the revenues from the export of the drogas do sertao, the Crown usually had to cover the budget deficits caused by expenditures with local government officials and Garrison troups. Only by the 1720s did Pará start to generate enough tax revenue to finance its government while São Luis continued in debit. Although the missionaries became financially important in Amazonia, due to the priviledged arrangements made in the regimento of 1680s, they were not required to pay any tax to the government (Furtado, 1969: 98; MacLachlan, 1972: 367).

As seen in the first part of the dissertation, the soils of Amazonia are generally poor in natural fertility. Apparently the settlers and the Portuguese authorities were unaware or disregarded this and the latter continued trying to promote agriculture production using various types of policy instruments. Demonstration farming was

used as were tax incentives like the import exemptions for 12 years offered by the Crown to those who planted coffee or cinnamon. In 1743, King João V adopted a policy of exclusivity to the coffee produced in Amazonia and Portuguese Asia in the Portuguese market. Indians were also given to those settlers in order to promote agricultural production. In general, however, these policies were not successful (Boxer, 1962: 299; Simonsen, 1969: 373, 367; Gross, 1969: 261-6; Reis, 1974: 36-7; Gross, 1975: 213).

Pombal and the Labor Problem

As has been discussed, the lack of adequate supply of labor--skilled and unskilled--was always one of the concerns of the settlers and of the Crown, and was seen as a reason for the agriculture production failure. The population in the Amazonia was mostly Indian. In 1685, for instance, Belem had less than 500 non-Indian inhabitants. Europeans were a minority in the colony and included small farmers, missionaries, spice collecters, business agents, artisans, estate owners, military personnel, and public officials. There were also many cross-mixes who were usually ostracized by both parental groups. In addition, a few blacks had been imported.

The Indians were the fundamental labor force, but their accessibility was always problematic for the colonists. Diseases continued to be the main cause of reduction in the Indian population through the late 1600s and 1700s. Smallpox epidemics occurred not only in the more Urban areas--even after variolation experiments had been

successfully applied in the region--but also in the tribe villages. Measles were also reported to occur in deadly epidemic proportions among the Indians. Many of these outbreaks were caused by the importation of unhealthy African slaves. As before, these epidemics reduced drastically the labor force and pushed the Indian "slave" expeditions further and further westward. The Indian labor force issue was always critical in this period of the Amazonian history (Kiemen, 1954: 180; Gross, 1969: 269,271; Simonsen, 1969: 306; Sweet, 1974; Gross, 1975: 220; Meggers, 1971: 151).

The relative prosperity of the aldeias under the missionary control in the last decade of the 17th century and first half of the 18th century contrasted with the economic difficulties faced by most of the colonists. When Sebastião José Carvalho e Melo, later the Marquis of Pombal, rose to power in 1750, this issue was high in his agenda for the state of Maranhão and Grão-Pará. Pombal had big plans for Amazonia not only in geopolitical terms, as has been noted above, but also in terms of the socio-economic situation of the colony.

In one of his first actions toward the region the Marquis appointed his brother, Francisco Xavier de Mendonça Furtado, as Governor-general of the colony in 1751 and to put forward his plans for the region. In 1752, Pombal officially started the operation of the Guaporé-Mamoré-Madeira route between Mato Grosso and Belém. The new administration also determines the end of the bater system of exchange and introduced money in the colony[10]. From the beginning Pombal decreed the elimination of the lingua geral, which was based on one

of the principal Indian tongues found in Brazil, and which was used in common speech in Pará up to 1750. Portuquese was to be used by all from that date on. The government suspected that the use of this language by the missionaries was a tactical attitude of the Orders so as to exclude those who could speak only Portuguese of having influence over the Indians. Therefore, Portuguese was to be used by everybody from that period on.

But one of the major moves of Pombal to affect the socio-economic situation of the colony was related to the Indians. He blamed the sad situation of the settlers in the region on the way the Indian villages were being administrated. Pombal also wanted a change in the role of the Indians. Since Portugal could not supply sufficient numbers of settlers to occupy the region, he rationalized that a civil union of the conquerers (the Portuguese) and the conquered (the Indians) under the same laws, with the same rights, and without distinction based on origin, would transform the natives into allies in the occupation of the colony. At the same time, this change in the way the Indians were to be treated would produce their economic integration as labor in a free market. These and other preconceptions held by Pombal about the missionaries and the mission system, provided the justification for profound changes in Indian policy.

But the Jesuits were powerful and the Pombal administration went cautiously about the change. It has been considered to be likely that Mendonça Furtado had arrived at Belém already with instruction to address the issue, but it was only in 1775 that a law abolishing the

temporal authority of the missionaries and secularizing the missions was enacted. Even then, Furtado preferred to withhold the publication of the law for almost two years as a political manuver to build a case against the mission fathers. By 1759, the Jesuits had finally been expulsed from the colony and sent back to Lisbon.

Indian Directorate System

In place of the missionary system, a new system was developed by Furtado, which incorporated the new philosophy of economic and social integration of the Indians into the Portuguese culture. The Diretório dos Índios, or directorate system, was established also in 1757 as a temporary--though with undetermined end date--measure to exist while the Indians learned their new role in society--assuming normal responsibilities of a Crown subject and an appreciation for the benefits of labor. The final goal would be to incorporate the Indians in the economy and society as liberated and willing civilized christian workers. The directorate was a system of forced acculturation.

In the meantime, the directory system provided for the transformation of the large aldeias into vilas do Reino, or townships, under the command of secular directors appointed by the governor. These directors would only offer technical assistance and guidance to Indian chiefs, who were to be the real administrators. This, however, ignored the varied manners by which decision-making was traditionally performed in the Indian societies. The vilas were also open to authorized European settlers so that they could provide a

pattern of civilized behaviors for the Indian, in addition of being a means to expand Portuguese colonization inland. Intermarriage, which before was seen adversely, was now officially encouraged in order to promote the principle of racial equality.

As before, agriculture was also encouraged by the directorate system. But Furtado understood the importance of the forest products in the region's economy and, hence, he also promoted their production. For that, the new system determined that the income of the village directors would not be a fixed salary, but rather it would be a commission of 16 percent of the value of the items collected or produced in common by the villages. Since forest products continued to be the principal commodities in the region, this provision would assure the director's determination in promoting their production. In addition, later credit schemes were developed by the government to finance forest products collection. Unlike during the missionary system, this time the villages would have to help to improve the tax revenue of the government.

The directorate also addressed the demands for labor by the settlers, but not as favorably as they had probably expected. As before, the Indians of each vila were divide in two equal groups. One half would be divided among the settlers who were to pay their salaries, in advance, for the maximum of six months at a time. This policy was detrimental to settler with low capital. The Indian fixed minimum wage, which was adjusted upward and varied with the skills required, was to be deposited in full amount with the director of the

village. The other half would remain in the village to be allocated to agriculture, forest products collection, or other taskes by the director. The group which remained in the village would also attend local government demands for labor.

But the directorate system did not work out in practice as Mendonça Furtado had planned. One of the first difficulties of implementing the system was the lack of well qualified individuals willing to perform the role of director in remote Indian villages. Furtado had to compromise and ended up appointing low ranking military personnel--who were not the most qualified individuals for the task. This was one of the major reasons for the complete distortion of the directory system. These directors became, instead of advisers, tyrants of the villages and illegal trade and corruption were not uncommon. They were reluctant to release Indians to the few settlers who could afford the salaries advance payment. They allocated most of the Indians in the most profitable task in Pará, the collection of forest products. Cacao in particular, which because of supply problems from Venezuela--the principal world producer at the time--was having its price between the years 1790-1815 increasing in Europe. The government also made extra requests for the royal service--construction, lumbering and shipbuilding, and defense and fort construction (as mentioned above). Indian death, by diseases brought by new groups of slaves imported in Pará, or by mistreatment also continued during the directorate period. These factors combined with Indian desertion--from vilas as well as from the royal services--continued, reducing the labor

pool, demanding resupply expeditions to occur.

Free Labor Market

By the 1790s, the government had lost almost all control over the directors. At this point they were, more than ever, forest products entreprenuers occupying a public office. The access to the Indian labor village by the settlers was almost nonexistent. However, many of the Indians who escaped from the vilas went to the cities where they could find many colonist willing to pay--more than the government set minimum wage--for their services. The settlers also offered better working arrangements and a larger profit share in order to attract the scarce labor. A free labor market had developed stronger than before, which in a way was accomplishing the economic integration goal that Pombal had wanted.

But the free market labor system was inadequate for the government to attend the demands of the royal service. These increasing difficulties led governor Francisco Souza Continho to propose the end of the directorate system to the Crown. He reminded the Lisbon authorities that the system had been developed as an interim apprenticeship system. He suggested that the time had come to accept the Indians and descendents as full members of the Portuguese society. The Crown agreed and abolished the directorate system in 1798.

After the liquidation of the directorate system, the government implemented a policy of free labor force, but saving for itself the right of forced draft at low wages. The Indian villages then suffered

a substantial reduction in population size, since most Indians and mixed-blood preferring to move closer to the major urban centers of the time. A free labor market had been almost completely evolved by the end of the XVIII century (Boxer, 1962: 275; Kiemen, 1954: 74, 178-80, 186; Furtado, 1969: 99n; Simonsen, 1969: 312, 332, 339-43; MacLachlan, 1972; MacLachlan, 1973; Santos, 1980: 20-1).

Companhia Geral de Comércio do Grão-Pará e Maranhão

Another important economic decision made by Pombal in the first years of his administration was the formation of a commerce company for the Northern colony. The Companhia Geral de Comércio do Grão-Pará e Maranhão, created in 1755 and lasting until 1778, had a monopoly over all commodities imported and exported in the two captaincies. Until its creation, few Portuguese merchants were tempted to send ships to the colony and the settlers had to put up with high freight rates and with paying higher prices for imported goods.

The company improved Grão-Pará's cacao export conditions, but its greatest impact was felt in Maranhão. The company was also encharged with the importation of African slaves into the Colony. It was São Luis, however, which received the bulk of the slave importation. Since São Luis was closer to Africa, it usually received the ships first, which favored their settlers in the choice of the best individuals. Unlike in Grão-Pará, where the forest products extraction was the most important economic activity, Maranhão had to rely more heavily on agricultural production. With the availability of the

better suited African slaves, the captaincy improved its agricultural activities. Cotton and rice became the most important commodities produced. The economic situation in Maranhão was further improved later in the century when its cotton production was favored by the supply problems of this commodity from English North America during its armed rebellion (1776-1783). The economic prosperity in São Luiz allowed the settlers to buy more African slaves. Another factor which favored this prosperity was the beginning of the industrial revolution in Europe and the increasing use of cotton in place of wool as the main raw material in the textile industry. By the turn of the century, Maranhão had overcome Pará as the most important economic area of North Brazil[11].

In Pará, as discussed above, the cacao production—which relied on Indian labor instead of African slaves—continued to be the most important economic activity. Meanwhile, cattle were introduced in the grazing areas of Rio Branco by the end of the century (Prado Jr. 1967: 72; Simonsen, 1969: 312, 333, 342-9, 369; Furtado, 1969: 99; Gross, 1969: 275; MacLachlan, 1972: 361; MacLachlan, 1973: 200; Santos, 1980: 19-20).

The End of the Brazilian Colonization Period

The end of the XVIII century and the beginning of the next were also years of substantial change in the Amazonian political arena. As discussed above, Portugal ever since the end of the "Babylonian Captivity" period was an ally of Great Britain. Napolean I, in his anti-British policy in Europe, saw Portugal not as a neutral Crown as

the Portuguese claimed, but rather as an English collaborator. Consequently, he decided to invade the small Iberian nation in 1807. Under this threat, the Prince-Regent Dom João decided to move his family and the Crown's headquarters in 1808 to Brazil, its most important overseas colony.

Napolean I had also shown interest in France's colony in South America, and several times during the turn of the XVIII century he tried to expand its borders southwards in disregard of the 1713 Treaty of Utrecht. By 1807 France and Spain, a traditional British enemy, had even agreed, according to the Treaty of Fontainebleau, on how they would divide Brazil and other Portuguese colonies between themselves.

Soon after his arrival in Brazil, the Prince-Regent declared war against the expansionist French nation and annul all treaties signed with that country in the past—which included the Utretch treaty. A few months later a military expedition was organized in Grão-Pará and, after a week long battle, Portugal possessed the French colony in January of 1809. This occupation lasted until 1817 when, after an agreement with the new French government of Louis XVIII, Portugal returned Guiana without retaining any of its lands. But the Luso-Brazilian occupation of the French colony seems to have been more costly for Pará than for the Guianans[12].

Despite the advantages brought to the Amazon Region by the opening of the Brazilian ports to friendly nations by Dom João in 1808—which until then were restricted to Portuguese ships—the general socio-economic situation of the area became increasingly worse. The

price of cacao had started to decrease since 1805 in Belém, although in Amsterdam this price continued to increase until 1813. Since this forest product continued to be Grão-Pará's major export commodity, that year marked the beginning of an economic decline in the region, which would last for many decades. Maranhão's economy also declined during the period because of the reopenning of the North America exports.

Also in 1808, Barra do Rio Negro--later known as Manaus--became the capital of the captaincy of São José do Rio Negro, a consequence of its economic importance in the captaincy, though its economy was still substantially smaller than Belém's. Manaus also entered in economic decline in the period.

With the death of D. Maria I in 1816, a year after Brazil had been elevated to the class of Kingdom equal to Portugal, the Prince-Regent became King João VI two years later. João VI would command the Portuguese United Kingdom from Rio de Janeiro until 1821 when he returned to Lisbon to address the mounting discontentment with the absence of the King from the mother country. He left in Brazil his son and heir Dom Pedro as Prince-Regent. Less than one year later, his son declared independence and became Emperor Pedro I of the Kingdom of Brazil. This episode is considered by most historians as the end of the Brazilian colonial period (Vianna, 1967b: 7-12, 28, 32-3, 52; Simonsen, 1969: 348-9, 358; Tambs, 1974: 65; Santos, 1980: 28, 30, 32-3, 36).

IV.3 Brazilian Empire and the Old Republic: The Rise and Fall of the Rubber Economy

The first decades of the Brazilian Empire were marked by economic and political uncertainties. Continuing the trend initiated during the last decades of the colonial period, the economic decline of Amazonia worsened during these first years. The collection of wild cacao, the first product which dominated the region's economic life since the 1760's, continued the decline initiated during the first years of the XIX century due to falling prices in the international market. The shortages of labor aggravated by the 1808-1817 French Guiana occupation by a Pará military expedition were still being felt.

The economic situation elsewhere in Brazil was also difficult, due to the lowering of prices for sugar and cotton and the reduction of gold output. These circumstances combined with a series of domestic and foreign events resulted in the end of the Brazilian first Empire. Portuguese born King Pedro I abdicated his throne in favor of his Brazilian son, infant Pedro II--at the time only 5 years old--who according to the 1824 constitution would have to wait until he was 18 to become king. Meanwhile, a period of regency took place.

Two triumvirates and two single regents elected by the General Assembly acted during this period, but they were not very effective in dealing with the economic situation and the intrinsically political instability of the period. During this phase, Brazil saw a series of provincial revolts, one of which took place in Amazonia.

Cabanagem

The Amazonian movement had started as political disputes between Portuguese and Paraense factions of the Belém elite. But soon it outgrew its original motives to become a mass conflict which had devastating economic and social consequences. The Cabanagem--from the word cabano, roughly meaning guerilla--movement became one in which Indians, caboclos, and blacks could express their discontentment with elite dominations, and claims for their rights to a larger role in the political and economic life of the province. It started in Belém, but quickly had spread hundreds of miles upstream, destroying the last vestiges of the directorate system. The revolt, which was most active between 1835 and 1839, was interpreted by the regency as a separatist movement and the Emperial troops ended it. The heavy losses due to reduction of economic activities, and destruction of capital, combined with the dramatic loss of the labor force due to death--estimates of the number of death vary between thirty to forty thousands persons out of a total population varying between 125,000 and 130,000 prior to the uprising--as well as escapes from bondage, further decreased Amazonia's economic and social situation.

The regency period ended with the proclamation of infant Pedro II majority in 1840 and with his formal coronation a year later. This event is said to conclude a phase of Brazilianization of the government which had begun in 1808. The first task of the new king was to reestablish peace in his domains which he soon accomplished (Burns,

1980: 167-77; Furtado, 1969: 137-8; Oliveira, 1983: 216; Reis, 1972: 67 cited by Santos, 1980: 35; Reis, 1974: 38; Santos, 1980: 16-36; Weinstein, 1983a: 123, 137; Weinstein, 1983b: 13).

Hhevé

While in Amazonia the economic situation was difficult, in Europe and in the United States a series of events had been taking place which were to change the face of the region forever. Many of the first Europeans who arrived in the new world noticed the use by the Indians of a different material with very peculiar characteristics. The Indians of Amazonia called it Hhevé and used it to make balls with which they played, to patch canoes, to make bottles, shoes, and syringes. They obtained this material in a liquid form--milk like color--from trees, and before it coagulated, they fashioned it in various shapes for different uses. This forest product had unique properties of elasticity and impermeability. Although the Europeans took notice with surprise of this new material and the Portuguese even learned how to use it, it would be only in the XVIII century, that the scientific European community received the first serious communications about it. The first was Charles Marie La Condamine, a Frenchman who in his mission for the Paris Science Academy in Amazonia during the 1730s, informed that body of the Indian uses for this forest product and its properties. In 1762, the botanist Fuset Aubley first described one of the many tree species from which the liquid could be obtained and named it *Hevea brasiliensis*. For the next decades, a small demand was

being created for this product in Europe as a substitute for various expensive leather goods such as: capes, shoes, hoses and others which need to be water proof. In 1782, the problem of making the coagulated material again fashionable was solved by Francois Fresneau. This created the possibility of the material to be transported for long periods of time and still be fashioned into various products. One Englishman found that the gum could be used as an excellent eraser and soon it became known as rubber. By the first decades of the 19th century, several other technological developments had occured that permitted the appearance of the first rubber products factories in Europe and the United States. They offered less expensive and better quality shoes and impermeable textiles for clothing.

However, one problem still remained with these products. That was the tendency of rubber to become soft and sticky in the heat and hardened and breakable in the cold. Charles Goodyear, an American, solved this problem in 1839 by a process which involved the use of heat and sulfur--which inspired the use a few years later of the name vulcanization, which is derived from the roman mythological god of fire and craftsmanship, Vulcan. This invention allowed the use of rubber for new products as well as the improvement of the already known ones. Hence demand for the raw material increased.

But the technological innovation which would really trigger the so called rubber boom between the 1890s and 1912 was the rubber pneumatic tire which was first used on bicycles and later on automobiles. John Boyd Dunlop, a verterinarian from Belfast, patented

in 1888 the tire an invention he had first used on his son's bicycle. The bicycle craze which started in the 1890s combined with the automobile's invention soon after and its increasing use created a fast-growing demand for natural rubber whose prices in the internation market skyrocketed (Batista, 1976: 130; Furneaux, 1969: 148; Fonseca, 1970: 36; Oliveira, 1983: 217-9; Poppino, 1968: 140; Santos, 1980: 42-9, 200-3; Weinstein, 1983a: 123, 129-30; Weinstein, 1983b: 8).

Rubber Production and Labor

Rubber can be obtained from the bark of several plant species of trees, vines and shrubbs of which Hevea brasiliensis was the most important not only for its productivity, but also for its high quality and abundance in the Amazon region. As most plant species in tropical forest, seringueira[1]--as Hevea brasiliensis is known in Brasil--does not grow in uniform stands, but rather spread apparently randomly over the forest.

Initially rubber was collected from the neighborhoods of Belém on the Marajó and Gurupá Islands. The use of the primitive technology of felling down the specimens which then were squeezed with the use of ropes to obtain the latex, practically destroyed these better located seringueira trees. During this phase, rubber production was in a sense similar to the collection of most other drogas do sertão but with a further negative element. Cacao production, for instance, was made by collecting parties which, during the fruit bearing season, would collect them from a certain area and then move to the next. Rubber

production was also done in this way, however, unlike wild cacao collection, rubber producers would not return to the same sites next year as cacao producer could. Rubber production process was more similar to a mining process whereas cacao production was renewable. Fortunately, there was a technological change which allowed rubber production without the distruction of the tree. This change, however, brought a new feature to rubber production which had not been observed with other forest production. This new method, to be described in greater details later, for the first time allowed the use of a piece of forested land for the production of income for extended periods of time. The latex liquid could now be collected every other day for as long as the dry season lasted. This brought a new dimension in Amazonian development since it allowed the production of income from a single forest track for extended periods of time. Before we go any further in evaluating the impact of this production process on the region, it is necessary to discuss other important factors of the mid nineteen century Amazonia.

As has been seen, labor--during the period, one of the basic production inputs in Amazonia, as well as in other areas in Brazil--was always a recurring concern for the region's elite. After the end of the Cabanagem revolt, the situation was in one of its lowest points. The rubber production, which was becoming increasingly important, did little to divert the great concern of the few hundred plants and ranchers who formed the backbone of the Amazon political elite at the time. The dispersed Indian and caboclo population of the period found

in the production of this new forest product a way to obtain exchange means. By the thousands, they were responding to the rising rubber prices by becoming _seringueiros_--rubber tappers. Furthermore, the passage of the 1850 Imperial land law, allowed some of these seringueiros who had acquired squatter's rights to become small estate owners by registering their claims[a]. However, as rubber prices increased, the control of these small holdings was passed into fewer and fewer hands.

Not surprisingly, the traditional political elites disliked very much the growth of the rubber economy. There was even an attempt to revive the worker's corps--made up of drafted non-white males who were not employed regularly or could not prove ownership of property--but by the 1860s it had been abolished. As little could be done to avoid increasing allocation of labor inputs into rubber production due to its strong market incentives, those elites and their public officials allies often blamed rubber collection for the apparent decrease in agriculture production. As will be discussed below in more detail, the labor situation would only have a significant relief after the late 1870's when massive numbers of Northeast Brazilians would migrate to the region (Batista, 1976: 134; Fonseca, 1970: 27-37; Oliveira, 1983: 224, 226, 228; Reis, 1974: 71; Resor, 1977: 344-6; Santos, 1980: 59-63, 69-75; Tambs, 1974: 71; Weinstein, 1983a: 124-5, 128; Weinstein, 1983b: 42-3, 265).

Commercial River Transportation

Institutional and technological changes in Amazonia during the period also helped to set the stage for the rubber boom to come. Through a pattern which would repeat itself many times throughout Amazonian history, Brazilian central authorities would act in response to real or perceived threat on the national sovereignty over the Amazon. This time it was not the ever-present concerns about the Brazilian neighbors in the region, but rather it was the behavior of a new nation-actor in the game.

The Nineteenth Century was a period of renewed European and United States expansionism in Asia, Africa, and Latin America. Of particular concern to Brazilians were the pressures imposed by France, England, and especially the U.S. in order that Brazil allow foreign steamship operations on the Amazon River. The most impressive of the approaches used seem to have been that of Lt. Mathew F. Maury, Director of the U.S. Naval Observatory in the early 1850's. He was the most vocal of those promoting an intense campaign to open the river to international navigation, so that the treasure-trove of Amazonian tropical riches could be unlocked through proper investment. He also tried to promote the use of the Amazon Region as dumping site for southern planters and their slaves. Of course, Brazil repudiated such ideas and decided to pursue policies toward the Amazon Region, once again as a reaction to a foreign threat. The result was an invitation to Mauá Baron, one of the most dynamic Brazilian enterpreuners of the time, to create a steam ship navigation company. He accepted the

challenge and in 1853 the Companhia de Navegação e Comércio do Amazonas (the Amazon Navigation and trade Co.) was incorporated with tree boats and with an extra task of promoting colonization in the region.

The introduction of steamships in Amazonia improved substantially the transportation services which up to then was still based on the labor of Indians and caboclos. This innovation freed part of the labor force previously dedicated to transportation which helped other economic sectors of the region. With the growth in economic activity, Mauá's company was successful and in four years he had invested more and increased the number of the company's steamships to ten. With the growth in the navigation business two new Brazilian companies were created to operate in the region in the 1860's.

The growth of the rubber economy, the severity of war between Brazil and Paraguay, and Brazil's own demands for free navegation in the Prata River, led the government of D. Pedro II to finally open restricted navigation on the Amazon River in 1866 to start in 1867. But by that time, the attention of those Europeans and North Americans was turned to other parts of the world. Hence, it was only in 1874 that the first foreign boat would arrive in Manaus, the Amazonas provinces's capital[3], to be loaded.

Meanwhile, an English-based firm, the Amazon Steam Navigation Co., began operating on the Amazon River in 1872. By 1874 this company had defeated the Brazilian pioneers and became the largest steamship line in the region—a position it kept throughout the rubber era. It

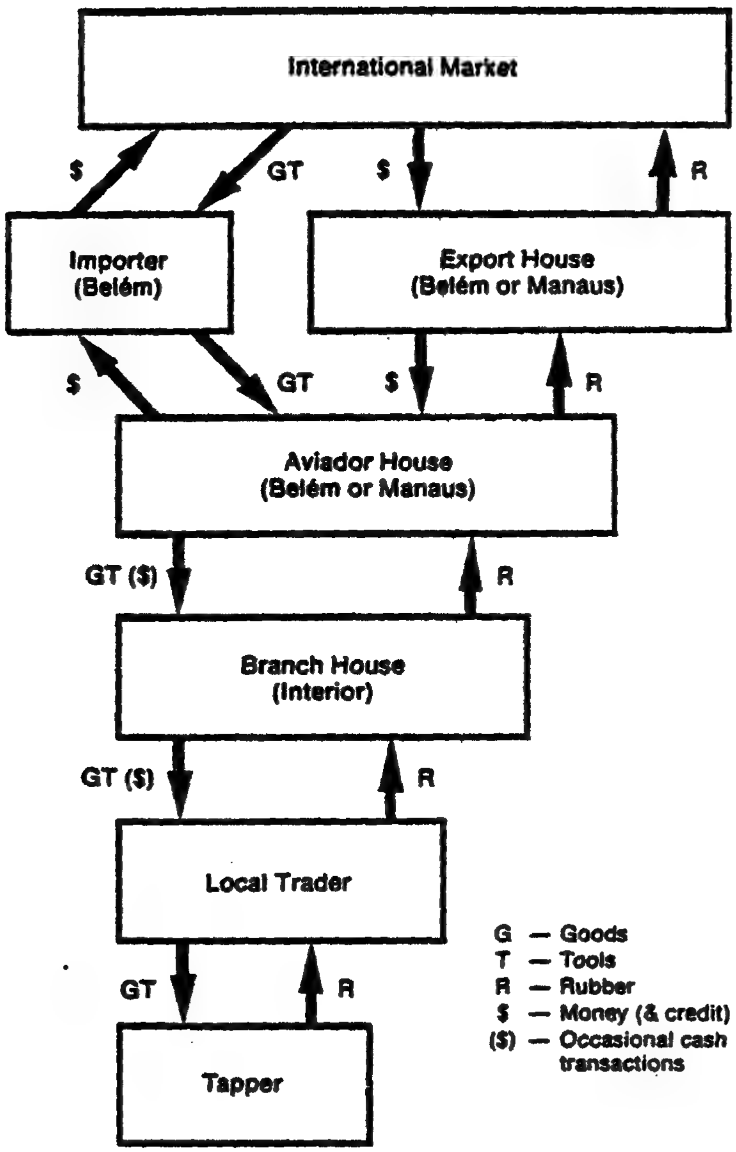
should be noticed, however, that private steamship also grew in the period (Galey, 1979: 264; Oliveira, 1983: 221-2; Santos, 1980: 53-8; Weinstein, 1983b: 61-2).

Aviamento

During the years of the rubber dominance of the Amazonian economy a system of financing, production, and trade developed in the region involving several actors. It evolved from an existing system of production and trade of drogas do sertão to be a system of debt peonage, which dominated the region throughout the period and which can still be observed nowadays. The basis of the system relied on the method of rubber collection which demanded that the seringueiros stayed in the forest for extended periods of time. He needed supplies as well as the ability to market his output which the aviamento system helped to develop. In the next few pararaphs a basic pattern of this system will be described in greater details although several variations did exist. Figure 33 presents a schematic presentation of the aviamento system.

The base of the system was the rubber tapper. As mentioned before, Hevea brasiliensis occured throughout most of the region in more or less numbers per unit of area. As always, the river system was the basis for transportation of goods and the inhabitants of Amazonia would locate themselves along the banks. Therefore rubber estates, or seringais, developed along the river. The formation of a seringal consisted of the simple task of identifying rubber trees

Figure 33: Schematic Presentation of the Exchange Network of the Amazon Rubber Economy.



Source; Weinstein, 1983a: 134.

in an area and creating paths through the forest, estradas, which interconnected from 100-200 trees. This aws the task of a specialized workers known as mateiro. The distance between those trees would vary from 100-200 m forming trails five to six miles long. The estrada had generally an eleptic or drop shape so that after going through a collection round, the seringuero would return to the starting point of the trail which was also its end. Each seringueiro usually worked on two of those trails in alternate days. A seringal could have several estradas.

The rubber production technology was also very simple. The daily routine of a seringueiro was ardous and time consuming. Early in the morning he would enter the estrada which he had not worked the day before and would make a cut on the bark of each rubber tree and leave a small bowl to collect the white liquid. Back at his hut at the end of the barely discernable forest trail, he would eat and take a siesta. He then returned to the estrada this time collecting in a bucket the latex accumulated in each bowl left in the morning. His day was not over yet since now he had to coagulate the rubber in a time consuming and health hazardous process. It consisted of a smoking process--learned from the Indians--which required the seringueiro to rotate slowly a rubber-covered paddle over smoke of acid vapors from burning plant resins until the various layers of coagulated latex would form rubber bails. This time consuming technology left very little time for other activities including agriculture. This process would usually be repeated every other day throughout the dry season, which made rubber

collection a seasonal business.

This very simple production technology received very few improvements throughout the period. It was derived from the interactions of those pioneers with the forest and the Indians and was very compatible with the region's environmental conditions. Furthermore, as in the case of most other forest products produced in the period, this technology allowed the resource to renew itself.

The rubber balls prepared as described above would be accumulated for a couple of weeks and then be brought to the local trading post--barracão--operated by the seringueiro's patrão. The patrão, or boss, was the second element of the aviamento system. He enjoyed a monopolistic as well as monopsonistic position before the seringuero. He could be either a seringalista--the land estate holder* who "leased" the estradas to the tapper for a percentage of his rubber production--or the aviador--a local merchant who marketed the rubber balls and supplied the tappers with tools, food, clothing, and any goods that they could afford, usually at inflated prices. These services were also provided by seringalista. In the Barracão the rubber was weighted and a series of accounting procedures would take place often resulting in debt by the tapper. As an illustration, in some cases 10 percent would be deducted from the original rubber weight to account for the rubber "shrinkage." The patrão would then keep half of the remaining weight as his payments while the other half would be

the seringueiro's. From his half another percentage would be taken from the serengueiro to pay for transportation and port costs. Whatever was left would be used to deduct from the tapper's debt at current rubber prices--usually lower than market prices.

If the patrão's accounting exercise turned a positive balance, it was paid in cash. But such cases were unusual for various reasons. First, the tappers were normally brought to the seringais by the patrãos who would charge for their transportation costs, tools, and food. This left the tapper with a substantial debt from the start. Second, the goods provided by the patrão to the seringueiros on their credit were "sold" at very high prices while rubber prices he paid were low. Next, the patrao discouraged subsistence activities--a factor adding to the natural discouragement of a time consuming rubber production technology--in order to keep the tappers as dependent as possible. Last, during the rainy season rubber was not produced, but the seringueiros continued to buy their goods on credit goods from the patrão, thereby accumulating debt[5]. Dispite this debt peonage, a special relationship between seringueiros and patrão many times developed. They saw the patrão also as their godfather, adviser and protector.

From the local trader, the rubber could be sent (1) by private boats or the Amazon Steam Navigation Co. ships to Manaus or Belém where aviador houses--wholesalers--were located, or (2) to an intermediate interior branch house and from there to the aviador houses of Belém and Manaus. That was because the patrão himself was a debt peon either of

the aviador houses directly or of intermediates--who in turn were debt peons of aviador houses. The goods he resold to the seringueiros were financed to him also on credit by these aviador houses to which he had to pay with rubber just as the tappers did with him. Likewise, the patrão also had to pay for river freight, warehouse and other charges for the rubber as well as for the goods he bought.

The aviadores* were the most important elements of this rubber production and trade chain. They were not only the central element in buying dry and wet foreign goods from the import houses to be supplied downwards until the seringueiros, but they were also the ones who negotiated with the export houses which in general acted as agents for rubber-buying firms in Europe and the U.S. Unlike with the rest of the aviamento system, the export houses were usually controlled by foreigns. By the 1880s, about two thirds of all Amazonian rubber was being exported by four foreign export houses--American, British and German. In most cases the aviador houses sold their rubber to these exporters, but in other cases they contracted the export's services on a commission basis. These were where money transaction really happened which could then be used to buy imported goods (Batista, 1976: 129, 134-5; Katzman, 1975: 280-1; Resor, 1977: 346-7; Santos, 1980: 155-75; Weinstein, 1983a: 124-5, 127-8; Weinstein, 1983b: 16-22, 27, 30).

Droughts in the Northeast and Labor for Rubber Production

Labor in this production process was very important and the aviamento system permitted its control rather than the land's--which

was less scarce. Due to the labor intensive technology used, the increase of rubber production in the region depended heavily on the availability of extra workers. New estradas would have to be open to production. This characteristic of the rubber production process contributed for the relatively low price elasticity of rubber supply. This characteristic was also evident from the various price increases that resulted from the demand shifts discussed above and which did not lead to great responses from the supply side.

Since the beginning of the 19th Century, interregional migration, besides the intraregional ones already mentioned, occurred--in special from drought prone Northeast Brazil[7]. Since the economy of the region had been facing structural changes from a sugar and cattle economy to an economy of subsistence, these droughts usually provoked the outmigration from that region. This push factor became extreme during the terrible 1877-8 drought during which almost all cattle of the region died and between one and two hundred thousand people perished. This drought initiated a process of immigration to Amazonia which, when combined with the effect of later droughts, led to a move of an estimated more than tree hundred thousand people to Amazonia until 1910. This mass movement of northeastern to Amazonia was possible in part by the work of Amazonian firms' recruiters of drought refugees in some of the port cities of that region--especially Fortaleza-state of Ceará. They offered advanced payments as well as "free" passage to their work place--which later would be part of their debt in the aviamento system. The illusions of fast richness in

Amazonia combined with the Northeasterner's stereotype of coffee workers--which were also in need in South Brazil--as slaves whereas as seringueiros they would be free lancers, "owners" of the rubber they collected, made the choice of moving to Amazonia easier".

These immigrants in most cases became seringueiros in new and more remote areas of the region where they were incorporated by the aviamento system. This move to more distant areas provoked an increase in rubber production as well as an expansion of the Brazilian Amazon region for which further details are provided below, but they also worked in agriculture, especially in parts of Para as will also be discussed below (Furtado, 1969: 139-42; Oliveira, 1983: 226; Resor, 1977: 345; Santos, 1980: 92-102, 106-8; Weinstein, 1983a: 127; Weinstein, 1983b: 39, 84).

Forest-Based Prosperity

The Amazon, which for the first decades of the nineteenth century was so depressed economically, was now observing a dramatic improvement in income level from rubber sales, though it was poorly distributed. The prosperity, especially during the rubber boom period, brought by the production of this forest product was best observed in Belém and Manaus, the two major cities of the region and provincial capitals. There the aviador houses and the exporters and importers as well as the great rubber Barons were located. By the 1890s, Manaus was then the richest and most modern city in Brazil. It had telephones, telegraphs, electricity, excellent systems of waterwork as well as

garbage collection and disposal, a custom's house which had been brought prefabricated from England, a floating dock--then the largest in the world--to deal with the substantial amplitude of the Rio Negro level (section II.3), other handsome public buildings as well as private residents, and the latest in Paris fashions were used. It also had a tramway system operating there before anywhere else in South America and even before Manchester or Boston. But perhaps the best examples of the forest based economic prosperity of the region was the Amazonas Theater, the magnificent Manaus Opera house, one of the greatest of its days. Belém also saw substantial changes, but they were relatively less dramatic than those which happened in Manaus (Burns, 1980: 335; Furneaux, 1969: 152-3; Poppino, 1968: 141; Resor, 1977: 352; Santos, 1980: 214-7).

Rubber and Territorial Expansion

The destruction of the seringueira trees around Belém, mentioned above, combined with increasing rubber prices as well as its production technology--to increase supply implied in an increase in land and labor--brought another important nowadays characteristic of Amazonia. As with the drogas do sertão, in the colonial period, the rubber production frontier areas were being pushed further and further westward along the rivers of the basin. The forest production activities of the northeasterns were bringing them to areas not well known and of dubious nationality along rivers like the Purus, Juruá, and others. This led once again to Brazilian territorial expansion in

the Amazon region.

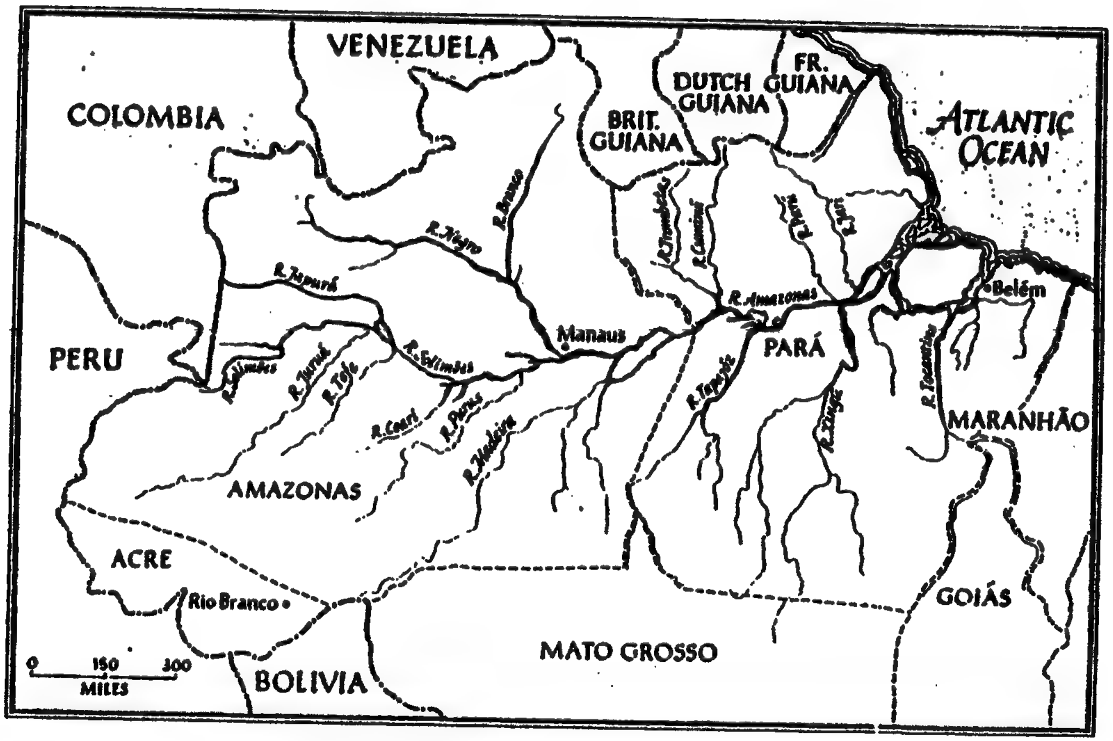
Already by the 1860s, several seringals were established along those rivers and in diputed territories. This resulted again in confrontation between Brazilians and Spanish speeking rubber tappers coming from the Andes eastwards. Confrontations between Brazilians and Bolivians occurred during this phase. In 1867, the Brazilian Empire and the Bolivian government initiated negotiations to address the problem on the basis of the same basic principle used in many instances during the colonization period, uti posseditis de facto*. The resulting treaty recognized Brazilian rights to territories in which its nationals were found.

But conflicts between Brazilians and Bolivians would not stop them. By the end of the 1800s, the rubber-rich areas of the upper Purus and Acre Rivers--a territory known as Acre--had an estimated population around 70,000 inhabitants of which the great majority was Brazilian. This area was formally a Bolivian territory but this government's authorities had problems controlling it. Conflicts between Brazilians and Bolivian authorities occurred again in 1899 when the latter tried to exercise control over the region. In 1901, the Bolivian government tried to solve its problems by consenting with the establishment of the Bolivian syndicate. This organization was owned by a British-American financial-industrial group and was to operate in the rubber-rich Acre region. It was given absolute powers over the region not only to pursue productive activities but also to have its own police, army, and navy as well as to perform civil administrative and fiscal activities.

This type of organization had been used by Europeans in Africa and Asia but was a novelty in Latin America. The Brazilian authorities, which so far had for the most part ignored the Acre conflicts, noticed with displeasure the creation of this organization. Meanwhile, the Brazilians in Acre continued their struggle for the region. Without any central government official support, they decided to create the Independent Republic of Acre by the end of 1902. This strategic move resulted in a more active response by the Brazilian central government, which, through the actions of its foreign minister--Baron of Rio Branco--obtained a new aggreement with Bolivia in 1903. Through the resulting Treaty of Petropolis, Brazil acquired the Acre territory and in return Bolivia received money, and an access to the Atlantic involving (1) land concessions at various points of the frontier including an access to the Madeira River, (2) the completion by Brazil of the Madeira-Mamoré railroad[10] which bypassed the madeira rapids giving Bolivian access to the lower Madeira, and (3) a commitment by Brazil of free river navigation rights to that country[11]. Figure 34 shows a map of the Amazonia as it existed c.a. 1910.

In fact, the Acre settlement by Brazil at that time was only another chapter of a series of border demarkations that Baron of Rio-Branco had initiated in 1895 with the settlement of the Missions territorial dispute between Brazil and Argentina. In late 1900, the baron had successfully argued the Brazilian case before the Swiss president--the aggreed upon arbitrator for the territorial disputes between Brazil and France--over what is now the Amapá territory.

Figure 34 : The Brazilian Amazon, c.a. 1910.



Source: Weinstein, 1983b.

Attracted by the presence of gold, diamonds, and rubber, the French did not respect the 1773 Treaty of Utrecht or the 1817 Brazilian return from Cayenne and kept trying to expand southward from French Guiana either by force or subterfuge. Their territorial claims, going up to the Amazon River's mouth, were found by the arbitrator to be groundless by the arbitrator and the boundaries between the two countries were settled.

Until 1909, Brazil's frontiers with Peru, British Guiana, Ecuador (then having territorial limits with Brazil), Venezuela, Surinam, and Columbia, had at least an understanding between them that would lead to boundaries demarkation. For these and other diplomatic accomplishments, Baron of Rio-Branco set a new course for Brazilian diplomacy, and his influence can still be perceived today in the workings of the Brazilian foreign ministry (Burns, 1980: 320-30; Oliveira, 1983: 219-20; Santos, 1980: 203-5; Tambs, 1974: 65, 70-4).

Brazilian Republic

Baron of Rio-Branco was working for the Brazilian Republic which had been established after the fall of Pedro II's Empire in 1889. In that year the army under the command of Marchall Teodoro da Fonseca, dethrowned the king, who then sailed to Europe in exile where he died two years later. Marchall Fonseca was elected by an assembly as the first Brazilian president. Less than two years later, the 1891 Constitution of the Republic of the United States of Brazil established a republican, presidential, and federalistic form of government

consisting of executive, legislative--congress with a senate and a chamber of deputies--, and judiciary powers. In the republic, the church was not a part of the government as it was during the Empirial Period. The old provinces were transformed into states, hence in Amazonia there were two states--Amazonas and Pará. The regime created was a very decentralized one, perhaps as a reaction to the over centralization characteristic of the Emperial period. States now had control over exclusively state matters. This included state control over all public lands in their territory--except for a frontier stripe--a policy which would survive in Brazil until the early 1960s when new national land legislations were inacted.

Marshall Deodoro da Fonseca resigned his post in late 1891 when his vice-president, Marshall Floriano Peixoto took the presidency. The first elected civilian president was a Paulista--i.e., from São Paulo state--President José de Morais in 1894. The decentralization policies of the new republic combined with the domination of national politics by the rural oligargy of coffee producers of south and central Brazil--São Paulo, Rio de Janeiro, and Minas Gerais--which dominated the country roughly until the late 1920s, had an adverse impact over the Amazon Region. This was because, as we will see in greater detail below, the end of the rubber boom occurred exactly during this period, hence the central government left the Northerners with their own problems (Burns, 1980: 277-300; Dean 1971: 624; Galey, 1979: 267; Katzman, 1975: 278).

Failed Attempts at Agricultural Colonization and Zona Bragantina

Labor, as discussed several times before, had always been a major concern in Amazonia. It was basic for forest-based production and trade, which dominated the region's economy, as well as for the agriculture enterprises. With the advent of rubber production, the local elites and public officials witnessed the apparent abandonment of agriculture activities. Concerns about this would last for decades as demonstrated by the regional governors' speeches of the period. With the increasing difficulties to involve Indians and caboclos in agricultural activities, it was once again thought that colonization--especially with foreigners--would provide a solution to the problem. Private and public attempts at this strategy were then made. One of the first of these attempts in the nineteenth century was that of Baron of Mauá who was supposed to promote colonization as part of his concession for steamship navigation and colonization in Amazonia. He tried to create two agricultural colonies with foreign immigrants--Portuguese and Chinese--but was unsuccessful. Between 1866-7, some 160-200 North Americans from south United States formed a colony close to Santarém, Pará. They also were unsuccessful and by 1871 there were only a few families left in that area. Other attempts of agriculture colonization with French, English, Spanish, Azorians immigrants were also made and again they were mostly unsuccessful. In

most cases the immigrants would abandon the colonies became seringueiros or went to the cities.

Despite these failures, a major agriculture colonization attempt, important for its size and consequences, was about to be made. With the urban growth of Belém, public officials were increasingly concerned with the supply of food and firewood which was becoming a serious problem. By 1883, at the beginning of the prosperous years of the rubber boom, an idea had evolved which related a transportation way--not a river system but a railway--and promoted agricultural colonization[12]. The idea was to build a railway crossing the tropical forest east of Belém connecting the provinces capital with the city of Bragança located some 300 km away. The railway would stimulate settlement by foreign immigrants and facilitate transportation not only of people, but most importantly, of the projected production to Belém's consumers. This area was seen as appropriate for the attempt because it was close to Belém and was not used for rubber production. Basic to this scheme was the assumption that the soils under the luxuriant tropical forest were fertile. But, as seen in section II.5, it is generally false. This was an assumption that led some of the contemporary visiting European scholars to assert that the Amazon Region could eventually become the bread basket of the world. Construction of the railway started in 1883 and as the tracks were laid down, agricultural colonies were started alongside it until the road was completed 25 years later in 1908.

A law in 1886 authorized the state government to promote the

immigration of some 100,000 foreigners to the so called Zona Bragantina in a 10 year period. Around five years later only slightly more than thirteen thousand had arrived--mostly Portuguese and Spanish--out of the projected 50,000 for the period. Various difficulties combined with the reduction of productivity of the soil after a few years of crop production led many of the settlers to abandon the area. Due to the high costs of each immigrant--who were brought by private companies which were paid by the quantity of persons brought regardless of their agricultural experience--the foreign immigration and colonization part of the project was dropped by the state government.

The evolution of the colonization was slow but continued. By 1901 there were fifteen settlements along the railroad stretchs already completed but only a total of less than seventeen thousand individuals. Most of these were Brazilians from non-Amazonian states--mainly northeasterners who had come to the region spontaneously in order to escape from the droughts that often affected their native land.

With the decline of the rubber boom after 1912 and with the spontaneous arrival of some 30,000 northeasterners caused by the great 1915 drought, the number of persons in the Zona Bragantina increased. They applied shifting cultivation techniques for the planting of usually annual crops in the poor soils of the region. The soil, without the forest protection, soon lost its small natural fertility by lixiviation and erosion due to the rainfall pattern discussed in chapter II. The use of these methods in such a large scale and short fallow periods resulted in the devastation of the Zona Bragantina. The

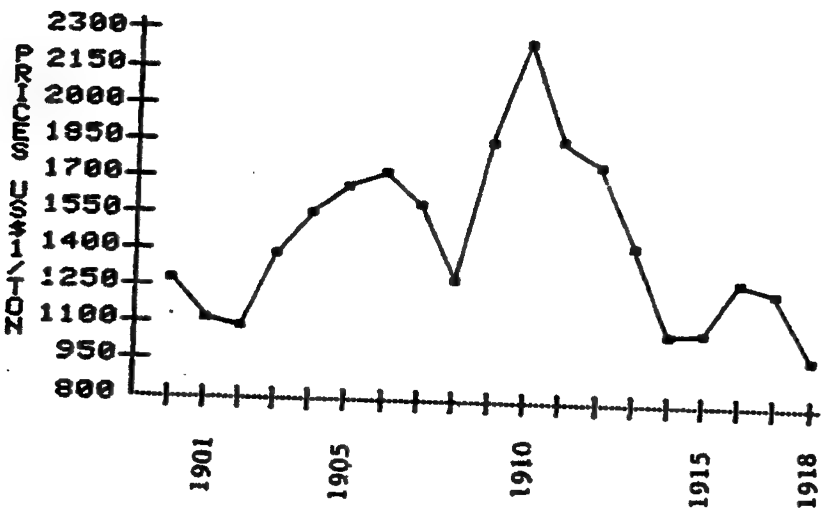
rich tropical forest areas were reduced irreversibly to unproductive sites which after abandoned were taken by shrub vegetation.

Various other factors are listed as causes for the failure of agriculture colonization along the Belém-Bragança railroad[13] such as the low qualifications of the foreign immigrants; government administrative failures and others. However, it has been agreed by most students of this experiment that the inaptitude of the sites to the type of colonization tried was one of the most important causes of the failure. The consequent decline of agriculture productivity became another example of the low carrying capacity of most Amazonian soils in their natural state (Fearnside, 1984: 48; Oliveira, 1983: 226, 241-5; Santos, 1980: 87-93, 102-6; Sioli, 1973: 326-8; Weinstein, 1983b: 102, 119-24, 255).

The Decline of the Rubber Economy

The fall of the Amazonian rubber boom which started roughly in 1912 was due to the substantial fall of rubber prices in the international market. (See figure 35.) This fall was provoked by the growth of the natural rubber supply getting to the market from the Asian <u>Hevea</u> <u>brasiliensis</u> plantations created from seeds obtained in the Amazon. Although several attempts had been made before, it was only in 1876 that a British subject who first succeeded in taking out of Amazonia the large quantities of rubber tree seeds needed to establish experimental plantations. Large quantities of these seeds were necessary because of the short period of time which they kept

Figure 35: Average International Rubber Prices, 1900-1918.



Source: Adapted from Santos, 1980: 236.

their germinative power and the large transportation distances between Amazonia and Europe. In that year, Henry Wickham, after learning of the availability of a large empty vessel in return to England, arranged for some 70,000 Hevea seeds to be collected in an area between the Madeira and Tapajós Rivers. He then charted the boat in the name of the Indian government and with the seeds on board and after a brief stop at the Belém's customs, Wickham went on to England to deliver them to the Kew Garden.

This episode and the circumstances in which it happened are still a subject of discussion for many. For instance, it is not clear whether or not Wickham was working for the British government in the collection of rubber needs. In addition, the moralities or legality of the seed export and the circumstances in which it passed throught the Belém's customs are still unclear. As put by Santos (1980: 230) in his recent book on the Amazon Economy during the 1800-1920 period:

> ...the circumstances in which he (Wickham) promoted the collection and the sending of the seeds were quite suspicious. Against Wickham there are accusations of fraud or contraband for his appropriation of the valuable seeds and their transportation without the Brazilian government's consent. [14]

The Sir Henry Wickham episode[15]--he received the noble title of Sir for his services to the British Crown, i.e., for obtaining viable rubber seeds--came to join various other episodes which throughout Amazonion history would leave Brazilians generally concerned about foreigner's activities in the region.

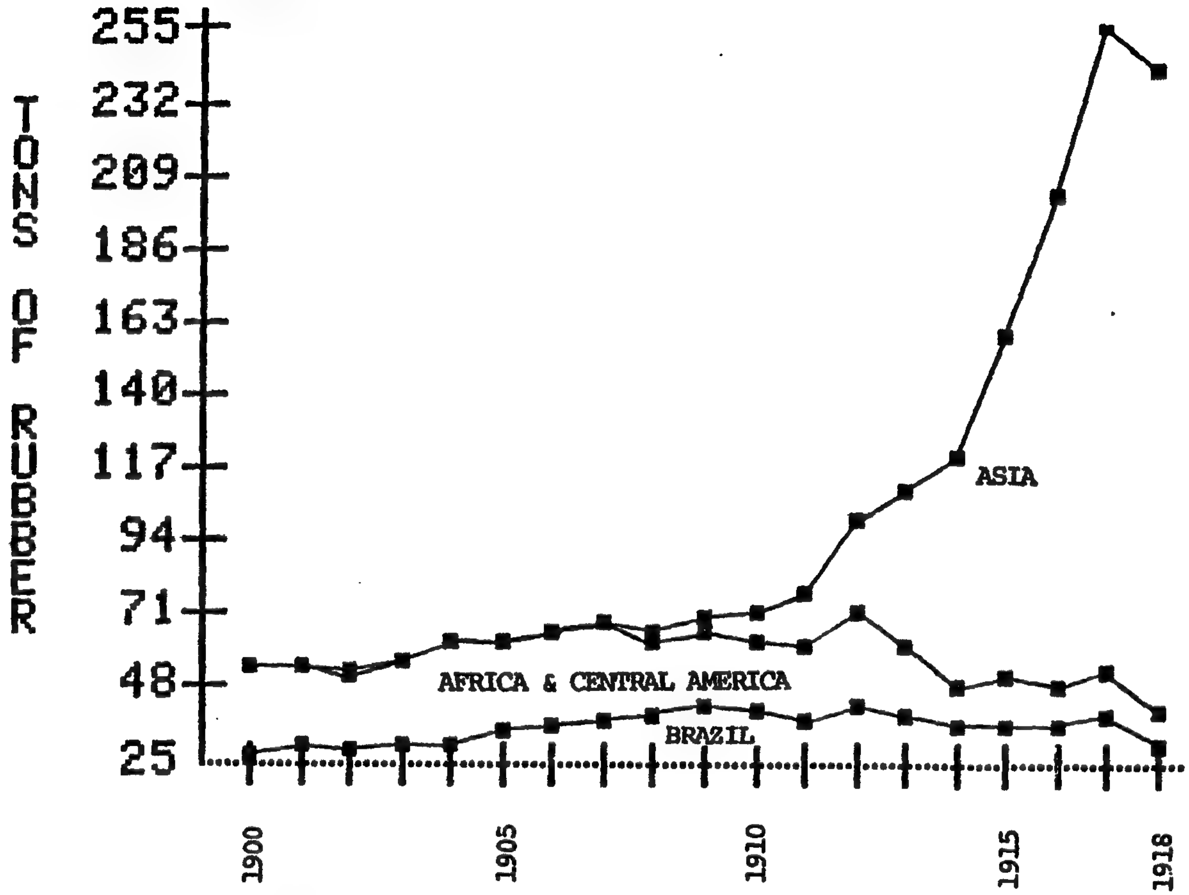
From the 70,000 Hevea seeds brought to the Kew Gardens, only a small fraction became seedlings. These seedlings were then transported

to Ceylon (currently Sri Lanka) and Malaysia to initiate experimental plantations along with other species which were also being experimented. By 1895 the research results indicated that *Hevea brasiliensis* was the best species for commercial plantations. Coincidently, this was a period of substantial price rises caused by the demand curve shifts provoked by the bicycle craze and the invention of the automobile. Commercial plantation started in a low pace but the strong price signals changed this rapidly. By 1905 only 53,000 ha had been planted but the rate was growing fast. Most plantations were made in Malaysia, Indonesia, and Ceylon. In 1910 there were 462,000 ha of rubber tree plantations in the orient, in 1915 the number was over a million ha. The *Hevea* trees took around 6 years to become productive, and by the beginning of the 1910s, the presence of Asiatic rubber supply was already being felt with a substantial effect on international rubber prices. (See figure 35 and 36.) By 1913 the more efficient Asian plantations were producing more than Amazonia had ever produced in a single year--which, incidently, had happened in the previous year. Only six years later, the Amazonian 1912 production record corresponded to only a little over one tenth of the Asian rubber production[14] (Fonseca, 1970: 38-42; Furneaux, 1969: 154-9; Resor, 1977: 342-4, 347-50; Santos, 1980: 229-40).

Attempts at Saving the Rubber Economy

During the Empire period, the distant and scarcely populated Amazonas and Para occupied peripheral positions in the central

Figure 36 : Rubber Production in Brazil, Africa & Central America, and Asia.

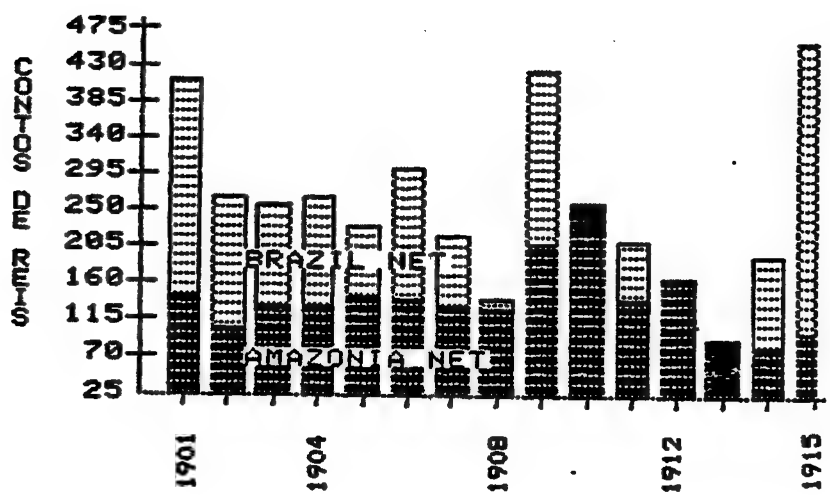


Source: Adapted from Santos, 1980: 236.

government's hierarchy. Their conditions during the Old Republic period was no different. Despite their increasing contribution to the financial situation of the nation during the late 1800s and early 1900s as illustrated in figure 37 and table 7 , the southeast-center coffee oligarchy dominated the country's decision making process. The substantial contribution to Brazil's balance of payment, illustrated in figure , and to the Treasury, shown in table , made by Amazonia during the rubber economy period, was not sufficient to improve the region's standing in the Southern dominated politics. This domination combined with the laissez-faire federalism existent in the period proved to be factors which helped to aggravate the situation of the Amazonian states as the rubber boom ended.

For several times, Amazonian political representatives sought help from the federal government, especially during the relative rubber prices fall observed in 1888-9, 1900-1, and 1906-7 years. These efforts had very little positive effects. In August of 1911, however, it seemed that the central government was finally going to act in favor of Amazonia. During a Rubber Congress held that month in Rio de Janeiro, the Minister of Agriculture of the Hermes da Fonseca government (1910-1914), presented a very ambitious plan to support rubber production in Amazonia. The Plano de Defesa da Borracha (Rubber Support Plan), which became law in January, 1912 (Decree 2,543 - A regulated by Decree 9,521 of April 17, 1912) tried to keep Amazonia's position as the major rubber exporter in the international market. It tried to do so by promoting (1) rubber plantations; (2)

Figure 37: Net Foreign Exchange Earnings by Amazonia and Brazil Total.



Source: Adapted from Santos (1980: 291).

Table 7: Amazonian Contribution to the Total Tax Revenue of Brazil and State and Federal Budget Expenses in Amazonia for Selected Years. (In Contos de Reis.)

	1890	1900	1910	1920
Total Tax Revenue of Brazil(1)	195,253	307,915	524,819	..
Federal				
.Tax Revenue From Amazonia(2)	10,465	28,840	84,799	..
.Expenses in Amazonia	3,269	6,183	12,361	7,503
.Balance	+7,196	+22,657	+72,438	..
.(2)/(1) %	5.4	9.4	16.2	..
Amazonian States				
.Tax Revenue	5,539	41,122	38,824	14,405
.Expenses	10,013	59,207	40,193	20,853
.Balance	-4,474	-18,085	-1,869	-6,448

Source: Adapted from Santos, 1980: 195, 295.

industries which worked with rubber; (3) immigration of more labor; (4) improvement of regional health conditions; (5) transportation; and (6) food production through agriculture and fishery--including processing industries. To execute the plan, a superintendency--Superintendência da Defesa da Borracha--was created as part of the Ministry of Agriculture.

This ambitious plan has been criticized because (1) of its size, especially given the financial and human resources available to the nation, and (2) it tried to save an activity which had little chances to compete in an international market on the verge of being dominated by the more efficient Asian rubber plantations. But this plan was short-lived and did not have a chance. A little over a year later Brazil's Congress refused to vote funds for the superintendency basically because of its low priority within a nation facing precarious financial situation. This comprehensive but abortive effort by the federal government would be its only attempt to help the region for the next 30 years. Until the early 1940s, Amazonia was once again neglected by the central government (Costa, 1971: 22-4; Fonseca, 1970: 137-8; Mahar, 1979: 2-4; Resor, 1977: 357-9; Santos, 1980: 247-56; Weinstein, 1983b: 221-2, 228-9).

Since the price elasticity of rubber supply in Amazonia was low, rubber production did not decrease as rapidly as the prices did. The decline was gradual, reflecting the fact that the movement of seringueiros out from the forest to the cities was slow.

However, of course, revenues from rubber sales did fall, as

illustrated in figures 38 and 39. This provoked several bankruptcies, especially of aviador houses. Foreign import and export houses were also affected and as the region's role in rubber supplies diminished, they gradually curtailed their operation and withdrew their agents from Belém and Manaus. In their place, the most successful aviador houses were taking over the foreign exporters' role under the same roof.

But several aviador houses were not as fortunate. Since the aviamento system operates in a series of relationships connecting the aviador house on one side to the seringueiro on the other, when one of those houses bankrupted it usually provoked a chain reaction which affected all of its members. Specific accounts of their fate are not readily available. It is known, however, that some seringueiros were forgotten while other were the objects of scorn and pity. Other seringueiros abandoned the forest and tried to go to the cities, but as evidenced by the slow rubber production decline and the variation the of the urban population proportion in the region from 21 percent in 1900 to 28 percent twenty years later, their numbers were not dramatically large. The least profitable seringais were certainly the first to be abandoned, which in many cases meant that the population dispersion process that was occuring during the rubber boom reversed. Some patraos allowed the seringueiros that stayed greater freedom so that they could produce part of their own food by shifting cultivation, fishing, and hunting. Other patrãos resorted to the use of force to keep the tappers in their seringais. All of these actions, however, could not affect substantially the effects of the drastic decrease of

Figure 38 : Annual Average of Rubber Export Value for Five-year Periods, 1866-1918.

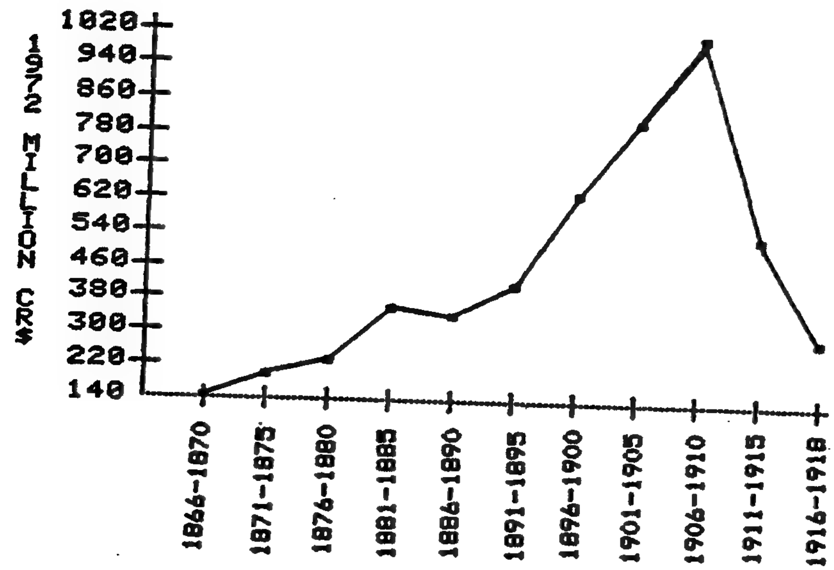
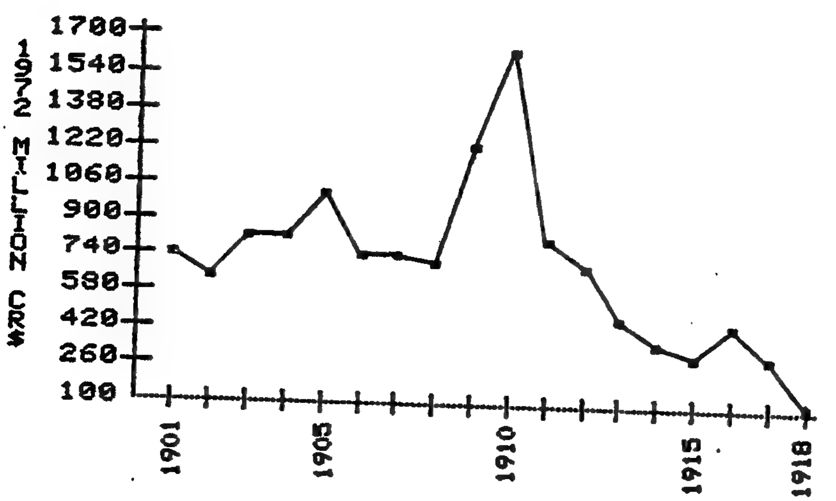


Figure 39 : Rubber Export Value for the Period 1901-1918.



Source: Santos (1980: 216) after Le Cointe.

rubber prices.

Other Forest Products

In this situation, other forest products were increasingly being produced. Lumber and rosewood were important but it was Brazil nut (Bertholletia excelsa) production which became an escape for many patrãos. Castanha do Pará, as it is known in Brazil, had been produced in the region even before the Cabanagem period. During the rubber period its production increased because its price in the European market--especially England--was sufficient and because its production process was not competitive with the rubber's. Unlike rubber, castanha is produced during the wet reason when the large fruits can be collect from the forest floor. With the decline of the rubber prices, the production of castanha became increasingly important with the growing participation of the U.S. in the Brazil nut market. The production of these nuts went from a total of 138,000 hectoliters in 1911 to 557,000 in 1919, corresponding to an average annual growth of almost 20 percent. By 1921, this forest product had taken the place of rubber as Pará's most valuable export commodity. Marabá, a city located south of Belém on the banks of the Tocantins River where it meets the Itacaunas River, became the most important Brazil nut producer in the Amazon Region.

But not every seringueiro became a castanha collecter. With the decline of rubber production many cabaclos choose, voluntarily or not, to stay in the areas where they lived. For many decades after the fall

of the rubber economy, these relatively isolated nuclear families and other rural dwellers constituted the major share of the Amazon population. These families obtained most of their basic needs from the tropical forest. Besides the traditional shifting cultivation practices by which they produced essentially manioc, they complemented their diet by fishing, hunting, and collecting fruits and other forest products. Shelter was also constructed with materials obtained from the forest. This way of life also gave the caboblo substantial freedom to choose how to allocate his time to his various tasks. This sense of autonomy combined with his known chances of survival imply in a high opportunity cost if this lifestyle is to be given up.

Consequences of the Rubber Economy

This pattern of population distribution, however, severely altered the political potential of this class and for the most part these inhabitants have been forgotten by public authorities. Although the caboclo population along the various rivers of the region had never formed a viable internal market, they were not able to pursue a completely self-sufficient way of life. They were accustomed to a variety of manufactured goods which they had been able to obtain from their patrãos or from the regataos who represented their linkages with the outside world. It was this need for industrialized goods which perpetuated the existence of the aviamento system. To be able to exchange or pay their debts, these isolated caboclo families had to produce tradable surplus. This surplus varies from season to season,

but in most cases they include rubber, Brazil nuts, animal skins, wood logs and other forest products.

In addition to (i) the dispersion of the major share of the population along the rivers in the form of isolated and cash poor family units, (2) the survival of the aviamento system of financing and marketing, (3) the rise of castanha do Pará as a major foreign exchange earner, other consequences of the rubber boom characterized the Amazon Region. One of these was the substantial increase in the number of inhabitants in the region although the average numbers per area continued to be very low. The large majority of this population was dispersed throughout the region along the rivers. Nevertheless a few relatively large cities like Belém and Manaus, with modern infrastructure, were consolidated in the period. The existence of those modern cities in the region was due to the prosperity brought the by rubber economy which reflected in the public financing accounts not only of the states but also of the nation. It was in those cities that the richest individuals of the region would live forming a new type of elite. Prior to the rubber boom the Amazonia elite was agricultural, but now it was overwhelmingly merchantile in its orientation.

The population growth of the period did not reflect the continued decrease in Indian population also observed. With the expansion of the rubber economy throughtout the Amazon basin new contacts between the white man and Indians happened. Combats between them and the seringueiros occurred, as well as massacres, enslavement, and diseases which once again resulted in substantial decline of the

already diminished Indian population.

Another important consequence of the rubber boom was the territorial expansion and occupation--better represented by the acquisition from Bolivia of Acre--as well as a improved knowledge of various rivers of the region.

One final point should be noticed before this discussion of the Amazonian sociosystem continues and that is the little environmental changes that were brought to the region by the forest products dominated economy of Amazonia. So far the region has kept its major characteristics as essentially a tropical forest region. The most drastic change inflicted on the ecosystem by this type of activity was the reduction in the frequency of some tree species such as the rubber trees--caucho (<u>Castilloa elastica</u>) as well as <u>Hevea brasiliensis</u>, rosewood, and a few others. The forest-based economy resulted in a very compatible way to colonize and occupy the region; in fact, the only way that has worked throughout its history. This fact contrasted drastically with the various unsuccessful attempts to promote agricultural colonization in the region, of which the Bragantina Zone agriculture colonization project was the largest and most dramatic example (Cardoso & Miller, 1977: 31-6; Oliveira, 1983: 230-41; Petey, 1972: 120-4; Ribeiro, 1977: 21-47; Ross, 1978: 193-4, 216; Santos, 1980: 182-91, 308-10; Velho, 1972; Weinstein, 1983a: 133; Weinstein, 1983b: 232-8, 241-6, 258, 261, 265-8).

Land Concessions to Generate Revenue

With the decline of the rubber economy it became increasingly difficult for the Amazon states and municipalities to pay for the borrowed money contracted by their predecessors during the boom years. The falling tax revenue combined with the Old Republic policy of absenteeism from state problems, led them to default on their foreign debt payments. In desperation, state public officials in the mid 1920s resorted to grant usufruct rights on extensive stretches of land for the exporation of any resources which could bring some tax revenue[17]. Land concessions were then granted to well-connected national merchants as well as to foreigners. Some of those concessions, specially in south Pará, were explored for Brazil nut production, while others were used for special projects on agriculture colonization projects. One of those concessions was to become a major attempt to create rubber tree plantations in Amazonia while other concessions were used to create agriculture colonization projects with Japanese immigrants (Galey, 1977: 23-6; Galey, 1979: 266; Oliveira, 1983: 251-2; Weinstein, 1983b: 258-9).

The first case is that of the Ford Motor Company's rubber plantation project which had been motivated by the rubber price controlling measures attempted by the British in the post World War I period. In 1921, 92 percent of the world rubber production came from East Asia of which the British controlled 75 percent. Since Britain was a relatively small rubber consumer while the United States used over 70 percent of the world rubber production, the British parliament

approved the so called Stevenson Rubber Restriction Act in late 1922 in order to artificially increase rubber prices in the international market. Britain needed high revenues so that its war debts could be paid and reconstruction could get under way. The Stevenson Plan as it became known, was simple. It stipulated rubber export quotas for British East Asian colonies based on earlier quarterly production and prices. The plan was enforced through prohibitive taxation for exports above the quotas.

The supply restriction imposed by the British achieved its intended purpose of increasing rubber international prices. In 1921, a pound of the best quality rubber was sold at 14 cents. By 1927 it had reached US$ 1.23 per pound, a substantial increase but not as high as they were during the last years of the rubber boom.

The British success in raising prices led North American industrialists to seek alternative rubber supplies. Under the influence of Harvey S. Firestone, the U.S. congress appropriated US$ 500,000 for studies of possible production areas in the world in order to determine the feasibility of establishing U.S. owned plantations. The head of the Firestone Tire and Rubber Co. also approached his friend Henry Ford to try to show him the opportunities of the rubber plantation business. Ford eventually yielded to his friend's arguments and, while Firestone invested in African rubber plantations, decided to look into the possibility of establishing rubber plantations in South America. With the active welcoming attitude demonstrated by Pará state administrators, Ford obtained 25 million acre land concession from the

state in 1927. The concession was located along the Tapajós River and was called Fordlândia.

The Stevenson Plan ended in 1928 and rubber prices would start to decline reaching record lows during the economic crisis of the early 1930s. But, as will be seen below, Ford did not get discouraged by the price decreases (Fonseca, 1970: 47-8; Petey, 1972: 113; Resor, 1977: 360-2).

Land grants were also given by Amazonian states for agriculture colonization. During 1925 and 1926, the Pará government sponsered the visit of Japanese officials to the region so that sites for agriculture colonization projects by Japanese peasant immigrants could be identified. Japanese colonization companies were created both in Brazil and in Japan and by 1928, land for colonization was officially granted by the state. These donations included 600,000 in the Município of Acará, 400,000 ha in the Município of Monte Alegre, and three other areas of 10,000 ha each in Marabá, Conceição do Araguaia, and in the Bragantina zone. By the agreement which resulted in these land grants, the Japanese government would provide transportation for the peasants from Japan to the colonization sites. In late 1929, the first 43 Japanese families arrived in Belém.

Land grants for Japanese colonization were also granted in the state of Amazonas in the late 1920's. However, it would be only at the beginning of the 1930's that they would have an effective beginning. In the case of Amazonas, Japanese presence was organized in a very peculiar way, as discussed below (Oliveira, 1983: 258-60; Petey, 1972: 127; Sioli, 1973: 328).

IV.4 The Vargas Era and a New Democratic Experience: A Brief Revival of the Rubber Economy and Attempts at New Directions for Amazonia

The laissez-faire decentralized federalism of the Old Republic began to disintegrate in 1922. Throughout the period dominated by the coffee elites of São Paulo and Minas Gerais, movements toward nationalism, modernism, and repudiation of the past developed. The decentralization policies of the period were seen as reasons for the nation's backwardness as compared to other young countries of North America. It was thought that only a strong national government could bring the nation's states to heal and provide guidance for economic development. Several revolts inspired by these feelings occurred during the period since 1922 and ended in 1930 with the overthrow of the Old Republic.

The new republic, under the leadership of ex-Rio Grande do Sul's state governor Getulio Vargas as president, moved toward the application of the principles which lead it to power. Strengthening of the central government--a feature which has characterized Brazil ever since--nationalism, and promotion of economic and social change were all introduced then and institutionalized through a new constitution in the 1930s. The Constituent Assembly which prepared this document also elected Vargas as president for a four year turn. But in 1937, the

president led a coup which would keep him in power until 1945. Vargas called his new regime Estado Novo, New State, and after constitutional changes, began to rule by decrees.

During the Estado Novo period, a new trend toward industrialization and urbanization started. Economic nationalism intensified during this period and the urban classes became an important political force. Vargas' ability to hold support from labor, the military, business, landowners, and the nationalists is credited to his long tenure and later comeback as elected president from 1950-54.

It was only after 1930 that the attention of the federal government turned to the Amazon Region since the Pombal administration during the colonial period. Initially, however, this attention was more in rethoric terms than in terms of actions. It would be only during the Estado Novo period that Vargar would be active in the region (Burns, 1980: 376-86, 404, 419-20; Galey, 1977: 227; Galey, 1979: 267-8).

The Ford Rubber Plantations

It was in this new national environment that Ford's rubber plantation project and the Japanese colonization would have to develop. Although the Japanese were not affected by these changes, Ford's project was. The growing nationalism of the period led many Brazilians to begin to wonder whether Ford might unduly exploit his large concession in Pará and thus violate national and state sovereignties. But the American industrialist had acquired an effective public image

since the Brazilian publication in 1926 of his book "My Life and Work" where he described his philosophy. The enlightened social and economic ideals that he wrote about made Ford's investments for the most part welcome in the country. But this did not mean that he would be trouble free with the state and federal governments.

Since Fordlândia was a large stretch of tropical forest with no prior settlement history, large investments in infrastructure were necessary. By the early 1930s the plantation site had extensive and comfortable housing, a school, a hospital with modern and sophisticated equipment, a power plant, water supply, roads, and a 25,000 board feet capacity sawmill. Plans for the sawmill were for the export of massive quantities of lumber and wooden auto parts. In what would be another example of poor management of Ford's project in the Tapajós region, company officials made some poor assumptions about Amazonia's forest resources. Instead of finding some few tree species as they were used to in the home country, they found that those forests had literally hundreds of different species corresponding to many different physic-mechanic characteristics. These features made the processing of wood for lumber as well as its marketing difficult. They also did not take in consideration the legal aspects of the sawmill project. They found out after its implementation that Pará prohibited the export of many types of timber. This constraint was eventually overcome but by then Ford had lost interest in this part of his Amazonia project.

Another dramatically poor judgement of the project manager was the choice of site for the rubber plantations. A company man, at Ford's

insistence, was chosen to direct the plantation operations in Fordlândia. Lacking any silvicultural skills, he choose a hilly location for the plantation of the rubber seedlings--produced from local seeds--which made most operations difficult and erosion control critical. Insects and diseases also attacked these first plantations which the manager did not know how to control. Realizing the difficulties of the project and perhaps the extent of his mistake, the plantation manager quit in late 1928 and returned to the United States. There was no one to take over the leadership of the project except a Danish captain of one of Ford's freighters who had just arrived at Fordlândia. Ford decided to keep the captain as his project's manager, a position he kept for 2 years only to be replaced by another company man from Detroit. Within the next year the company had two new additional managers who quickly gave up and returned to the United States. During this period, the confusion and waste generated by the incompetent management resulted in a complete disarray at Fordlândia. Only 4,071 ha were ever planted there.

Those and other problems finally led Ford to hire, for the first time, a professional agronomist with rubber planting experience. After visiting Fordlândia, he advised the company to start with a completely new plantation, in a more plain area and using high yield clones from Asia. Ford agreed and he immediately departed to Asia where he obtained 2,046 planting materials from 53 of their best selected clones. It is ironic that in fact, he was bringing them back to almost the same area along the Tapajós River where Henry Wickmans had

collected his seeds some 60 years earlier. In a reaction similar to that of the Brazilians at that time, but belatedly, the British, French, and Dutch Asian colonies prohibited the export of planting material.

By May 1934, the companhia Ford Industrial do Brasil had traded with the state of Pará 703,750 acres of its Fordlândia concession for an equal amount of land downstream on the Tapajós but in an area of plato. This new area was called Belterra and was also much closer to the city of Santarém. Tree cultivation at Fordlândia was reduced while in Belterra a new town was built for the employees. Planting of local Hevea brasiliensis bud grafted with high yielding Asian clones in the new site progressed rapidly.

Despite Ford's initial authorization for the changes proposed by the professional agronomist, the early unsuccess of Fordlândia combined with the decrease in rubber prices after the end of Stevenson Plan led the company to consider selling its properties to Brazilian investors in 1935. But the Brazilians claimed lack of capital and did not make any proposals. Left with few alternatives, the Ford Co. decided to expand Belterra's facilities and continued planting.

As many generations of interpreneurs before, the Ford Company also faced the basic problem of lack of a sufficient labor force. Recruitment of labor within and outside Amazonia proved to be difficult since by the 1930s the traditional Amazonia labor source, the Northeast Brazil, saw its workers prefer to migrate to the industrial and farming centers of southern Brazil. The company tried to import blacks from

Barbados but they were inexperienced and had difficulty adjusting to life in Amazonia. By late 1930s the company made another attempt to bring foreign labor, this time from Portugal, but this plan was interrupted by the outbreak of World War II.

Ford Company also had some problems dealing with the workers that it did contract. This despite the fact that workers received free home, free medical and dental care--Belterra had a 120-bed hospital--recreational facilities, and relatively good wages. Food and other supplies were provided at subsidized prices by local concessionaries closely monitored. This relationship between company and employees, however, was seen by many ex-seringueiros as too cold--a poor substitute for the traditional role of the patrão figure who was seen by them also as godfather, advisor, and protector. Accustomed to the freedom of the seringais, these workers were also reluctent to follow rigid work schedules demanded by management. This in fact led to some violance and even a riot when a cafeteria system was attempted at Fordlândia as a means of reducing lunch time breaks. Problems with labor also included debates on their rights to be paid vacations as Brazilian industrial workers were granted by law under Vargas' social changes.

These were important problems but probably not the ones which determined the company's giving up in 1946. By 1942, the Detroit's headquarters had lost interest in manufacturing tires and other rubber products and sold its tire plant in Michigan to Soviet Russia. By 1943, the United States had developed synthetic rubber and initiated a

substantial program for its production. This resulted in a reduction of the natural rubber demand which further contributed to the company's decreased interest in its Amazonian project. In 1945, Henry Ford II, Ford's grandson, became President of the Ford Motor Co. and began a series of cost cutting measures that included the elimination of the unprofitable plantations, and keeping mainly the car factories[1]. The US$9 million project was sold to the Brazilian government for US$500,000. Under the Ministry of Agriculture jurisdiction, Fordlândia was used for cattle raising while Belterra was transformed to a experimental station where a little rubber is produced (Fonseca, 1970: 47-8; Galey, 1979; Resor, 1977: 360-5; Sioli, 1973: 331-2).

It is interesting to notice that many of the problems faced by the Ford Co. in its Amazonia project would be repeated some 20 years after it was sold to the Brazilian government. The project-dream of Daniel K. Ludwig along the Jari River, as discussed in further details in appendix 4, would have many of the same problems as Ford's but, in most cases, with different end results.

The Japanese Colonization

The case of the land concessions for Japanese colonization in Pará and Amazonas states had different outcomes from that of Ford's. The first 43 Japanese families which arrived in Belém in 1929 were followed by others and by 1935 they totaled 362 families. The initial colonization plans asked for the plantation of cacao and rice as the main source of income for the settlers. But from the beginning they

faced problems and due to the high prices of food that they had to buy, the Japanese decided to create a cooperative in 1931 and produce horticultural products to sell in Belém. As most of the other agriculture colonization attempts before this, the immigrants were not successful and soon were reduced to subsistence agriculture. These difficulties combined with health problems resulting in the death of several community members led many families to abandon the Acará Município. From 1935 to 1942, only 98 of the 362 families had not left for south Brazil. These remaining families kept trying new cultures and a few years later they were successful in introducing black pepper (<u>Piper nigrum</u>) a species brought from East India.

However, the advent of World War II and the break of relations between Brazil and Japan brought difficult days to those families. They became seen as enemies and were confined to the colonization site under the administration of a state institution.

With the end of the war, the Japanese reorganized, established a new cooperative, and continued producing black pepper. With the increase in pepper prices, the colony of Tomé-Açú began to prosper and by 1953 new Japanese families arrived from Japan. The cooperative operated by (1) buying the pepper from the settlers and then selling it, (2) acquiring fertilizer, equipment and other inputs, as well as food and other supplies, and (3) providing health services. Many years after its beginning, this project became essentially the first successful agricultural colonization attempt in Amazonian history.

Various reasons can be listed for the success of Japanese in

Tomé-Açú. The well Known Japanese efficiency and ability to organize, innovate, and cooperate are certainly important factors. So is Tomé-Açú's location on the Acará River, only 270 km south of Belém by boat. This facilitated marketing of output and represented relatively low transportation costs to and from markets. The spontaneous organization of these settlers in a cooperative was also a factor. But it can be argued that one of the most important factors for their success was the cultivation of a cash crop. Unlike rice and other annual crops tried in previous agricultural colonization projects, black pepper is a perennial climbing vine. The Japanese were able to develop a technology appropriate to the poor soil found in Tomé-Açú's terra firme area. They use high amounts of chemical and organic fertilizers in a communal[2] production process which is supported by the services of a cooperative. The relatively high costs of this technology were only possible to be profitable due to good pepper prices combined with other factors contributing to reduce costs.

The success of the Japanese introduction of pepper cultivation in Amazonia would have an impact on the choice of crops by other colonists yet to come to the region. Although, for the most part, pepper production in Brazil is still dominated by the descendents of the original Tomé-Açú's Japanese immigrants (Cardoso & Muller, 1977: 46-8; Nelson, 1979: 118, 239; Oliveira, 1979: 258-63; Richardson & Stubbs, 1978: 197; Sioli, 1973: 328; Tavares et al., 1979: 42-3).

The Japanese who immigrated to the state of Amazonas also made an important species introduction, but it was done in a very peculiar

way. In early 1930s a Japanese legislator, Uetsuka, organized a group of scientists and came to a land concession given by the state in the proximities of Parintins on the banks of the Amazon River. There they created the so called Amazonia Institute where research on agriculture and hydrology of the Amazon River was to be done. Uetsuka himself returned to Japan where he created a school to prepare students to come to Amazonia. From 1931 to 1937 he sent 273 Japanese students and 6 families to Parintins. By 1934 they had successfully made another important species introduction. This time it was Jute (Corchorus capsularis), an Asian plant which yields a fiber used for sacking and cordage. This species was planted on várzea areas and the production technology that they developed was soon learned by some caboclo families who started producing it.

World War II had a more dramatic effect on the Japanese who had come to Amazonas than it had had on those who came to Pará. The Amazonia Institute was disappropriated and ended. Today Jute is a relatively important crop for the region and is produced on the várzeas of the mid Amazon River between Manacapuru in Amazonas and Santarém in Pará. But, unlike the successful Japanese cooperative experience in Tomé-Açú, Jute was produced by caboclo families organized under the traditional aviamento system (Cardoso & Muller, 1977: 43-4; Oliveira, 1983: 258-63).

Vargas, Amazonia, and the Battle of Rubber

The first decade of the Vargas era would see increased official rethoric about nationalistic issues, including about Amazonia. It would be, however, only after Vargas established the Estado Novo dictatorship in 1937 that some action would start. He used the argument that only an authoritarian regime which did not respond to an electorate could meet the needs of underpopulated, underdeveloped and uninfluential regions, as a reason to justify the desirability of his dictatorship.

Vargas spoke frequently of plans for the development of the interior. He created the program "March to the West", which, although applied mainly to the central plateau region--including the establishment of agro-pastoral colonies and a new capital for the state of Goiás, Goiânia--the concept also applied to Amazonia. In time with the current nationalistic views, Vargas proclaimed the movement towards the west as "the true sense of Brazilianism". He became the first chief of state to visit the interior in Brazilian history. In October 1940 he visited the Amazonas state and made the so called "Rio Amazonas Speech" in the Manaus Opera House where he unveiled his ideas for the region. He argued the need for an integrated territory which would help Brazil to become a more secure and economically powerful nation. He mentioned the need for an increased regional population and for the promotion of agricultural and livestock raising as contrasted to just forest products collection. Drawing from a 1933 concept, the president asked for the integration of the various Amazon nations through commerce and transportation agreements establishing the idea of

Brazilian leadership in multilateral Amazon development[3].

Vargas' promises to act in Amazonia would acquire a new dimension with the outbreack of World War II. War time demand for rubber started to grow and prices began to rise. The entry of the United States into the war and the Japanese occupation of Asia made Amazonian rubber one of the few source of this essential raw material available to the ally forces.

The prospects for an Amazonian rubber economy comeback seemed initially even better. It was then thought that, as the Japanese advanced in Asia, they might decimate the rubber plantations out of vengence, and when they retreated, they might even destroy the remainder to prevent the plantations from falling into allied hands. The distruction of Asian plantations combined with the increased war time rubber demand implied the possibility of a rubber shortage in which case Amazonian rubber would be extremely important.

Brazil's entry into the war created the possibility of a closer cooperation with the United States in terms of supplying raw material for the allied forces. Despite the nationalistic feelings of the period Vargas, accepted with reservations the foreign collaboration in Amazon development. But Brazilians insisted on full national participation in any Amazon program instead of the small role assigned to them in the American proposal during the negotiation period of a war agreement between the two nations. Vargas negotiators also used Amazon rubber as a good bargainning leverage to secure United States cooperation for other Brazilian projects including industrialization,

transportation and energy in other ports of the country. The negotiations resulted in the so called "Washington Accords" signed in March 1942 and lasted until August 1947. These accords included short and long run projects for the Amazon region and other areas of Brazil[4].

The signature of the Washington accords began a war effort in Amazonia that become known as the "Battle of Rubber". The major goal of this battle was to produce more rubber for the war needs of the allied forces after satisfying Brazil's own needs. To accomplish this, a complicated scheme was rapidly devised and implemented. It included the creation of several organizations encompassing credit, shipping and supplying, health and labor recruitment which were designed to displace the traditional aviamento system[5]

In July of 1942, Brazil created the <u>Banco de Crédito da Borracha</u>- BCB (Credit Bank for Rubber) as a private enterprise in order to stimulate wild rubber production through the provision of special credit lines to Amazonian persons or firms interested in the production, marketing and industrialization of rubber. BCB was also given a monopsomy power to buy all Amazonia rubber and monopoly power to sell all rubber production in excess of domestic needs to the United States at a fixed price. This excess production would be bought by the US Rubber Reserve Company (RRC) for a minimum price that would be adjusted to take care of inflation in the region[6]. Brazil contributed 60 percent of the bank's capital, obtained mostly from the national treasury and a small fraction from private interests, while

the RRC contributed 40 percent. This capital majority combined with the chairmanship and majority of BCB's board of directors, satisfied Brazilian nationalistic aspirations for ample authority and participation in the Battle for Rubber.

Since rubber production from plantations would bring results only after a minimum of six years--unsatisfactory for the immediate pressing needs of the war machinery--the Battle for Rubber compaign concentrated in the production of wild rubber[7]. But, as discussed above, wild rubber production was heavily dependent on the availability of labor. The labor situation in the region had worsened with the decline of the rubber economy since migration from rural Amazonia to the cities and to other parts of the country occurred. Initially, it was estimated that labor requirements for the battle of rubber would amount to 0.5 million imported workers, or rubber soldiers as the rhetoric of the time preferred. Once again, as in the past and in many instances yet to come, Northeast Brazil was to be the source of such labor. To promote the immigration of Northeastern into Amazonia, the federal government created in 1942 the Servico Especial de Mobilização de Trabalhadores- SEMTA (Special Service for Labor Mobilization). A drought in the northeast that same year apparently helped Rio officials to justify the need for that migration. However, northeast land owners and public officials wanted to retain the labor force there for future use. Although reluctantly, most states did yield to the federal government's pressures for cooperation except Pernambuco which flatly rejected the proposal. Despite the cooperation of most states, it was

still decided to suplement the northeastern migration with labor recruitment in southeastern Brazil.

Since ocean navigation was dangerous due to war enemy attacks, a plan for mass migration over land and on foot was designed by SEMTA. This attempt was not very successful and eventually the maritime route was also used. Besides the problem of bringing new labor to the region, it was also difficult to keep those who had come. Many of them found employment in Belém and Manaus while others deserted either when they heard of rumors of disease and hard working conditions in the forest or after a few days of work. By May 1943 only 9,000 of the 50,000 workers programmed to be mobilized by SEMTA for the period had arrived in the region. Because of this low performance and the inefficiency caused by institutional rivalries between Brazilian authorities for the control over the rubber program, SEMTA was substituted by the Comissão Administrativa de Encaminhamento de trabalhadores para a Amazônia-CAETA (Administrative Commission for sending workers to Amazonia) in 1944. Between 1942 and 1945, these organizations transported over 32,000 workers and their dependents to Amazonia.

Other organizations were also formed to deal with the problems of public health, transportation, and the provision of food and other supplies. To reduce the health problems in the region, the federal government created the Seviço Especial de Saúde Pública- SESP (Special Service for Public Health). SESP was responsible for assuring the physical fitness of the migrants as well as to provide medical assistance to Amazonian inhabitants, promote general sanitation, and

control Malaria. To deal with the transportation problem, the Amazon River Steam Navigation Co. was incorporated by the federal government to create the Serviço de Navegação da Amazônia e Administração do Porto do Pará-SNAPP (Amazonian Navigation Service and Para Port Administration). Also the Ponta Pelada Airport was built in Manaus and the Val-de-Cans Airport in Belém was improved. The problem of the supply of food and other goods to the region led to the creation of the Superintendência de Abastecimento do Vale Amazônico- SAVA (Superintendency for the Supply of the Amazon Valley). All those organizations had the support of the Rubber Reserve Company which in 1943 was substituted by the Rubber Development Company (Burns, 1980: 431; Fonseca, 1970: 138-40; Galey, 1977: 28-80; Mahar, 1979: 3-6; Oliveira, 1983: 263-7; Salgado, 1977: 44, 53-4).

Through Decree-Law 5,812 (September 13, 1943) Vargas also created three new federal territories in Amazonia to join Acre: Amapá, Guaporé (later Rondonia), and Rio Branco (later Roraima). As figure shows, these new territories--under direct federal administration--were located in areas bordering foreign nations. Federal intervention in these areas was justified by security reasons on Brazil's frontiers due to Axis influence in some neighboring countries and by the failure of the Amazon states to develop and efficiently govern these remote areas. The problem of rubber contraband to evade state export taxation was also a justification for this change. The strong Estado Novo had little problems overcoming the protest of Amazonian states which would loose tax revenues from those areas as Amazonas did when Acre was

created (Galey, 1977: 101-6).

But as mentioned before when the rubber plantation attempt by the Ford Motor Company along the Tapajós River was discussed, by late 1942 the US had changed its rubber strategy so as to rely more heavily on the recently developed synthetic rubber. Synthetic rubber production in the US would go from 8,400 tons in 1941 to 820,373 tons in 1945. The US also made institutional changes aimed at achieving more efficiency reflecting the new attitude. That same year, the Rubber Reserve Company was substituted for the Rubber Development Company (RDC) which would be independent and run by a board of businessman who would direct rubber collection overseas. These changes affected the Washington accords. In March of 1943, US officials drastically revised North America's role in the Amazon. They decided to concentrate solely on the most pressing war related wild rubber needs--which included special uses like airplane tires, electrical insulation and others. Vargas, perhaps realizing the consequences of the synthetic rubber on his bargaining power, also lost interest in the long term goals he tried to get for the Amazonian cause (Fonseca, 1970: 243; Galey, 1977: 72; US, 1942).

A new Estado Novo plan to develop transportation and colonization in Brazil's central plateau region and Eastern Amazonia as part of the March to the West program emerged. Vargas created Fundacão Brasil Central- FBC (Central Brazil Foundation) which involved private Brazilian funding and had as objectives to create agricultural settlements in these regions and transport linkages with

southern Brazil. FBC suffered from insufficient funds and, by the time it was terminated in 1949, it had built some airports but had little success promoting agricultural colonization (Galey, 1977: 99-101).

The government efforts during the battle of rubber did manage to substantially increase wild rubber production in Amazonia but never at the level of the best rubber boom years. Rubber production raised from 13,110 metric tons in 1940 to 22,944 at the end of World War II in 1945 and to 24,697 two years later at the end of the Washington accords* (BCB, 1961 cited by Salgado, 1979: 55).

Since the early fears that the Japanese would destroy the Asian rubber plantations did not materialize, the end of the war represented also the beginning of the decline of the brief revival of the rubber economy during the Vargas era. By the end of 1946, the low priced Asian rubber returned to the international market leaving Amazonia rubber unable to compete. With the end of the Washington Accords in July 1947, the Brazilians decided to keep BCB and its monopoly and monopsomy powers as well as the minimum price policy for wild rubber. These decisions combined with the growth of the domestic rubber industry--mostly located in São Paulo--from 3,865 metric tons of wild rubber consumed in 1939 to 24,087 tons in 1949, avoided a more dramatic collapse of the Amazonas economy as happened in the early 1920s (Fonseca, 1970: 138-44).

New Democratic Experience and New Directions for Amazonia

While those changes in the rubber economy of Amazonia were occuring, other substantial ones were developing in South Brazil. With the march towards victory of the ally democratic forces over dictatorships in Europe in 1944 in which Brazilian forces also participated, it became increasingly difficult for Vargas to justify his own brand of dictatorship in Brazil. The military especially put pressure on the president to return the country to democracy. Vargas made some movements in that direction, but it became increasingly apparent that he might try another coup to stay in power. The military then intervened and took command of the government on October 29, 1945. The chief of Justice of the Superior Court headed the country while new elections were held and a new constitution was proposed. Vargas retrieved to his native Rio Grande do Sul state while his Minister of War, General Eurico G. Dutra, was elected by the popular vote and took office in January, 1946 (Burns, 1980: 435-8).

The fall of Vargas would give rise to the search for new directions for Amazonian development. Vargas initiatives and rhetoric before and during the war caused a national recognition of Amazonia's significance for Brazil's economic maturity, national security and prestige. But the Estado Novo's piecemeal and disjointed projects approach to the region and its heavy dependency on a single product to revive the Amazonian economy was criticized. The debates of the period resulted in the conclusion that only a comprehensive development approach offered hope in confronting Amazonia's situation.

With the help of Northeastern and other representatives, the Amazonian delegation in the National Constituent Assembly obtained a constitutional commitment to Amazonian development. Article 199 of the 1946 Constitution of the United States of Brazil, the fourth in the country's history, stipulated that the Union should provide at least 3 percent of its annual tax revenue for the next 20 consecutive years to a plan for Amazonian economic support. The Union funds should be matched by equal percentage from Amazonian states and municipalities*. The initial agreement on the creation of this fund did not assure a way by which it should be used. The poor experiences of the past provoked a prolonged and inconclusive debate initiated in congress. In 1947, they created the Comissão Parlamentar do Plano de Valerização Econômica da Amazônia- CPPVEA (Parliamentary Commission for the Amazonian Economic Support Plan) to outline a program of expenditure. This move, however, did not solve the problem. The Northerners who dominated the commission and their advisors lacked experience and expertise in designing economic development programs. This fact combined with their other parlamentary responsibilities led to indecision and, by late 1940s, CPPVEA had failed to outline an Amazon program. Besides that, the initial enthusiasm and support of other congressmen to the Amazonian cause were decreasing because they returned to their own state interests. In addition, some states and municipalities did not fulfill their commitment with the Union to support the Amazonian plan with 3 percent of their own revenues. Due to the lack of Amazonian projects, President Dutra simply alloted

1948's funding to the Agronomic Institute for the North, to the Credit Bank for Rubber and to other plans which did not have too much to do with the region (Cardoso & Muller, 1979: 109-10; Saley, 1977: 82, 112-3, 122-7).

Despite the initial perspectives, effective actions by the government during these first years of the new democratic period of Brazil's history were in fact limited to dealing with the rubber economy. As briefly mentioned above, a new law approved by Dutra in late 1947[10] kept the BCB as the sole buyer of Amazonian rubber[11]. In addition, this law established that the 1944 rubber minimum price would stay valid until 1950. It also created a Comissão Executive de Defesa da Borracha (Executive Commision for Rubber Support) whose main tasks included restriction of rubber products importation through licensing procedures so as to benefit the national rubber and to promote domestic rubber industrialization. But in a few years it was apparent that BCB was accumulating large rubber stocks which had not been absorbed by southern rubber industries. This led to changes in the federal government's policy for the region. Law no. 1184 of August 30, 1950 transformed BCB into the Banco de Crédito da Amazonia-BCA (Credit Bank for Amazonia). BCA was now a bank for a region instead of a bank for a product and was to use ten percent of the funds of the plan for Amazonian Economic Support (Fonseca, 1970: 142-50; Mendes, 1970; Falgado, 1979: 56-7).

The International Institute of Hylean Amazon

The nationalistic movement that has been discussed above also was present in the post World War II period. One specific case is particularly relevant to be mentioned for its impact on Brazilian attitudes toward the region as well as for the resulting creation of an important research center for the region. This is the case of the International Institute of the Hylean Amazon- IIHA[12]. The idea of the need for a research organization in Amazonia was first developed by a Brazilian chemist Paulo Estevão de Berred Carneira in 1945. In 1946, perhaps inspired by Vargas 1940 Amazon Speech, he presented a proposal at a conference of the newly created United Nations Educational, Scientific and Cultural Organization-UNESCO. The proposal was molded to fit United Nations and UNESCO's internationalism spirit of the immediate post-war period, which was to draw upon the resources of many nations regardless of their political orientation. Carneiro knew the after war problems of relocating displaced persons and of nutrition and food shortages which had renewed international attention toward open living spaces like Amazonia. UNESCO's members accepted the Brazilian plan and the IIHA became this organization's first major sponsored project.

Initially the idea of a international research institute in Amazonia was welcome by Amazonian officials and the federal government. The Brazilian foreign ministry had endorsed Carneiro's proposal and Amazonia state officials felt that the institute would bring new life to the local economy through renewed world attention to the region.

But soon the poorly defined institute's activities began to generate controversy within Brazil. There were issues related to (1) the international control of the organization, (2) the moral neutrality of scientific research—especially after the creation of atomic bombs—, (3) the possibility of massive migration of international refugees to the region, and (4) the economic nature of research on Amazonian resources. These issues appeared to some as risks to Brazilian sovereignty in Amazonia.

These issues had not yet got to the Brazilian public and the IIHA project continued. Manaus was chosen as the main site for the project and its funds for the 1947-8 period were provided by UNESCO. But a permanent funding arrangement had still not been found for the institute. By May 1948, none of the Amazonian nations--Bolivia, Brazil, Columbia, Ecuador, Peru, and Venezuela--had made financial commitments to the institute. This financial problem was apparently solved that month during a IIHA meeting in Iquitos, Peru, where funding from each nation was agreed to be allocated on a territorial and population basis. The Brazilian delegation tentatively accepted the proposal since final approval should be given by the Brazilian congress.

IIHA funding problems seemed to had been solved when UNESCO itself started having its internal political problems. Still in 1948, the State Department of the United States, a major contributer to UNESCO's funds, arranged for an American to become the new director of the United Nations organization. In the midst of the Cold War period, the U.S. State Department believed that UNESCO intended to infiltrate

Amazonia with communists. As a consequence, the new director withdrew UNESCO's sponsorship from the IIHA project.

By 1949, the cold war was having an impact in Brazil where a new nationalist campaign targeted the IIHA as an ideal subject for emphasizing the need for national control of the nation's territory and resources. With the help of former President Arthur Bernardes (1922-6), the nationalists obtained national headlines. Some of the same issues discussed before once again surfaced but now in debates in the congress, the press, and the public. Arguments which drew from the historic examples such as the US Lt. Maury's 1850 plans for Amazonia were used and the issue was broadened. Soon the majority of the politically active population had agreed with the nationalists. The debate lasted well into the mid 1950's and, in fact, congress never decided on the Iquitos convention agreement. Instead it was simply "archived" indefinitely (Bourne, 1978: 34-5; Galey, 19977: 112, 128-75).

The nationalists' response to UNESCO's IIHA would come only with Vargas return to public life. Dutra's four-year presidential mandate was about to finish in 1950. Vargas, after being sure of no military objection, waged a vigorous campaign for the presidency. He based his platform on accelerated industrialization and expanded social legislation. He won the election with 49 percent of the popular vote and took office on January 31, 1951. He then initiated another series of institutional changes which included the creation of the Conselho Nacional de Pesquisas-CNPq (National Research Council)[13].

CNPq was a nationalist project which a year later served as the

basis for the creation of the Instituto Nacional de Pesquisas da Amazônia-INPA (National Institute for Amazonian Research) under its supervision. INPA was the nationalists' response to UNESCO's IIHA project. With time, however, it came to welcome foreign scientists.

The IIHA long dispute served not only to increase public awareness over the Amazonian situation but also to transform the issue of Brazilian development of Amazonia in one of the major nationalist concern and a very sensitive one among many Brazilians ever since. Also during this period, Vargas created a steel producing complex, a government-owned oil monopoly company (Petrobras), and he got involved in economic development planning through modernization and industrialization (Burns, 1980: 444-6; Oliveira, 1983: 267-8; Rodrigues et al., 1981: 7-9).

SPVEA

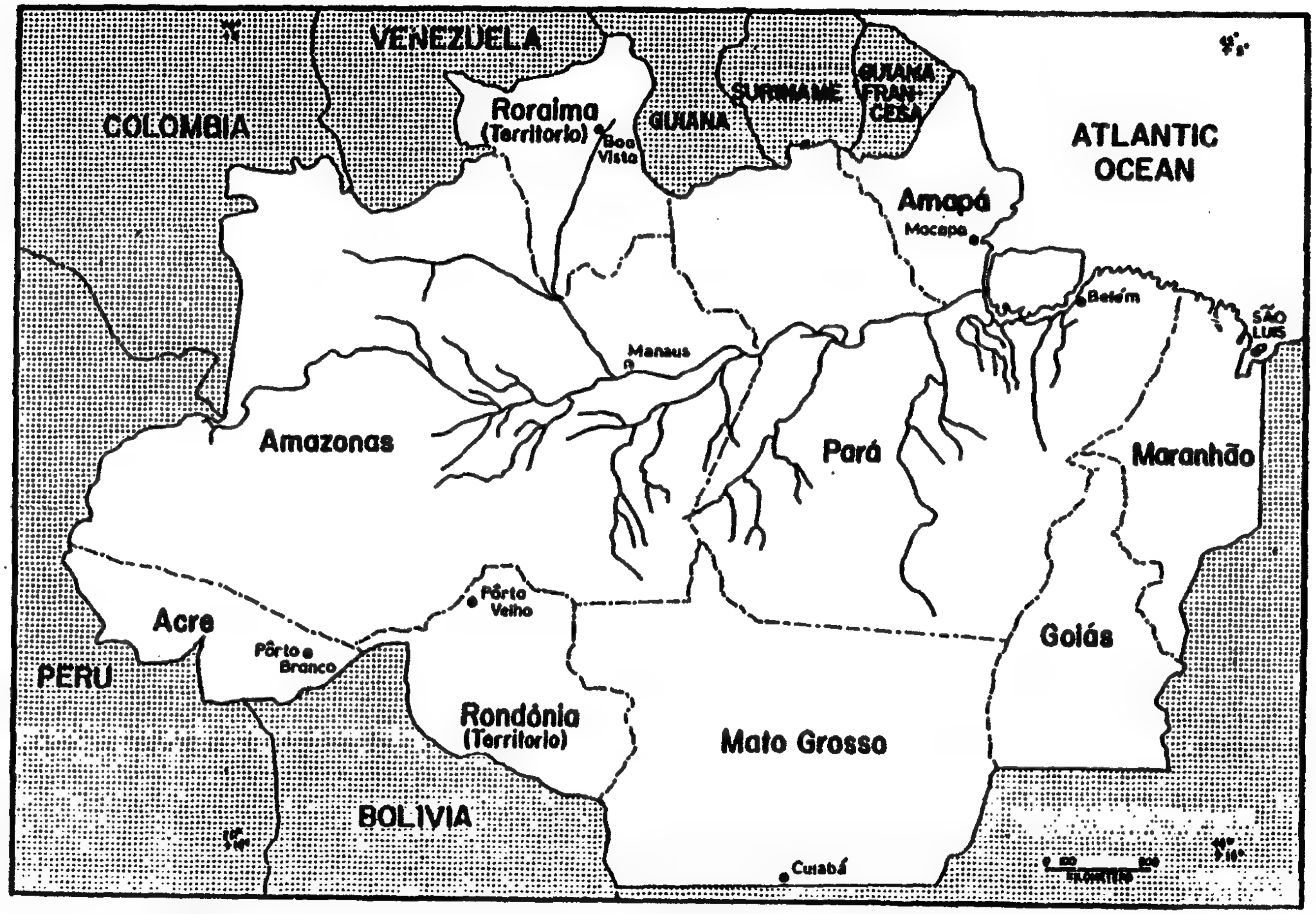
This new approach brought by Vargas was also reflected in Amazonia. After the disappointing impact of the battle for rubber and the six years of congressional failures to outline an Amazonian plan, the president decided to support the creation of a new federal organization especially for the region. Law 1806 of January 6, 1953 regulated article 199 of the 1966 constitution was approved by congress on February 11, 1953. This law finally outlined the Plano de Valorização Economica da Amazônia. It was a broadly conceived regional development plan which was designed to improve the social and economic well being of the regional population. It comprised a mix of

normative, strategic, and operational objectives which included a improvement of a system of services and public works designed to benefit the population directly (food, health, education, water and sewage, transportation, communication, and energy) as well as to promote agricultural, mineral, and industrial development.

To execute this plan, Vargas approved the creation of a federal organization: Superintendência do Plano de Valorização Econômica da Amazônia- SPVEA (Superintendency for the Amazonian Economic Support Plan). SPVEA was linked directly to the office of the president although its headquarters was in Belém. It was supposed to last for 20 years during which it would elaborate medium range plans (5 years) and coordinate, at the national level, the actions of other organizations operating in the region.

During the years which preceeded the creation of SPVEA, states bordering Amazonas and Pará and sharing in their territories some of the ecological characteristics of Amazonia tried to participate in the funds for the PVEA. With the creation of this new agency a compromise was reached. The area of jurisdiction of SPVEA was defined as including not only the states of Pará, Amazonas and the federal territories of Acre, Amapá, Rio Branco, and Guaporé--comprising the so called Classic Amazonia or North geographic region--but also parts of the neighboring states of Maranhão, Goiás, and Mato Grosso[14]. (See figure 40.) This large area represented 5,057,490 km^2 or two-thirds of the national territory. The region so defined is known as statutory or Legal Amazonia.

Figure 40: Map of the Legal Amazonia.



Source: Goodland & Irwin, 1975: 9.

Article 8 of law 1806 also created a fund for the financing of the Plan (Fundo de Valorização da Amazônia). This fund was basically made up of resources from the 3 percent tax revenue from the Union as well as Amazonian states and municipalities as defined by the 1946 constitution. Ten percent of SPVEA's budget was, however, earmarked since 1950 for BCA to be utilized in accordance with the objectives of SPVEA's medium term plans.

SPVEA's organization included a planning commission constituted of 15 members (one representative for each of the nine states and territories and six technicians) whose tasks comprised the elaboration, alteration, and review of the five-year plans, and the elaboration of annual budgets would be submitted by the president for congressional approval.

The planning commission took immediately its task and went on to prepare the first five-year plan (Plano Quinquenal) for the period 1955-1959. Meanwhile for the rest of 1953 and 1954 SPVEA put together an emergency plan, which in fact was the result of a series of political decisions. The five-year plan was prepared in a very short period and, also as a reflection of the state of the arts then, had little scientific foundation, being mainly a simple attempt to recognize Amazonia's major problems. The plan did express its regional development approach, as opposed to the rubber production support approach attempted during World War II. It had three stated objectives: (1) to assure territorial ocupation[13], (2) to build in Amazonia an economically progressive and stable society capable of, with

its own resources, promoting the execution of its social tasks; and (3) to promote regional development in a parallel and complementary fashion to the Brazilian economy. To achieve these objectives, SPVEA's original formulation called for three basic investment priorities. First, agricultural development for self sufficiency in foodstuff and to expand production of raw material for export and internal use. For that, SPVEA would promote research, colonization, and provide production incentives. The second group of investment priority included river transportation and ports (mainly), communication, and energy. The last group included health aspects through better hospitals and clinics, and water and sewage systems[16]. Other investment areas in SPVEA's plan included credit, education, and lost natural resources[17]. SPVEA operated through agreements with public and private organizations already existent in the region such as SESP, SNAPP, and IAN. Although a good deal of the investments proposed by SPVEA would not be sector specific, it is clear that the government was once again attempting to promote agricultural development in detriment of natural resources development.

The first five-year plan was, however, never approved by congress and SPVEA operated in the period through annual budget allotments (Cardoso & Muller, 1977: 109-12; Costa, 1971: 237-8; Galey, 1977: 126; Mahar, 1979: 6-10; Oliveira, 1983: 267-9; Salgado, 1979: 56-60; Schuh & Alves, 1970: 271).

Part of the justification for this situation is quite likely to be related to the changes which were taking place in Rio de Janeiro.

While SPVEA was concerned with its first five-year plan, in the country's capital the Vargas government was coming to a dramatic end. After a sequence of events which are beyond the scope of this study, the president commited suicide 17 months before the end of his five year term in 1954. His mandate was completed by vice-president Café Filho. Elections for president were held in 1955 when an ex-governor of Minas Gerais state, Juscelino Kubitschek, won. After some tribulations, the new president took office on January 31, 1956.

Brasília and the Belém-Brasília Highway

Kubitschek had priorities for his government which, although left SPVEA's five-year plan aside, would affect the pace of Amazonian development substantially. Just a few months after taking office, the new president had finally made the decision to build Brasília, an old Brazilian dream to move its capital toward the geographical center of the country[18]. The rationale for this change had evolved through time. In the early days of the Old Republic, it represented a shift of the face of the country away from the coast, which meant links to the colonial past. Later it was seen as the opportunity to create a new indiginous urban form; and finally as a growth pole that would accelerate the march to the west, promoting the social and economic integration of the country.

The fast work pace of Brasília's contruction started in early 1957 and the new capital was inaugurated three years later. To link the capital to other parts of the country, Kubitschek also approved a

national transportation plan which included eight highways radiating from Brasília. One of these highways was the Belém-Brasília road for whose construction the government created RODOBRAS under the supervision of SPVEA. Construction of this 2,064 km road initiated in 1958 using substantial portions of the <u>Fundo de Valorizacao da Amazônia</u>. Due to some delays, the road would become passable throughout the year only in 1964, and pavement was completed nine years later in 1973[19]. The construction of the Belém-Brasília highway combined with other factors brought substantial social-economic changes to south-east Pará and northern Goiás (Burns, 1980: 448-9; Katzman, 1977: 43,47; Katzman, 1978: 42-51; Schuh & Alves, 1970: 271; SUDAM, 1969: 70).

The economy of southeastern Pará after the fall of the rubber boom became based on Brazil nut production. During the 1930s, diamond and crystal river prospection began to be part of that region's economy. There was not much labor competition between those two activities because they are complementary. As in the case of rubber and Brazil nut, prospecting was done when rivers are with little water volume (dry season) while Brazil nut production was concentrated during the wet seasons. There also existed small cattle production but it was mainly to supply meat to the local population. During this period, the land supply was abundant, the population small, and economic production was dominated by the aviamento and barracão systems. In this situation there was no need for those who had land possessions in these areas to obtain legal land titles by the state government as Law no. 601 of 1850

granted them. There was also a high opportunity cost associated with the legalization process such as time wasted, travel, etc. Hence, few actually obtained land titles (Santos, 1979: 105-9; Carvalho et al., 1979; 203-8, 212-3).

With the construction of the Belém-Brasília highway, substantial socio-economic changes would begin with a modification in the occupation pattern of this part of Amazonia from river-based to highway-based, in a similar way as happened before with the Bragantina railway. This highway started the history of the current frontier expansion in Amazonia. With the reduction in transportantion costs from the Maraba area to Belém and the population growth of Pará's capital, cattle began to be produced to supply part of Belém's market. From South and Southeast Brazil came, spontaneously, subsistence settlers as well as large land grabbers. These land grabbers saw an opportunity to buy cheap land or take possession of public (state controlled) land and make speculative investments to obtain capital gains brought by the improved land access. A speculative race, which still goes on in several areas of the region until today, to get Amazonian land had started.

The states of Mato Grosso and Goiás have also been affected by this new wave of land grabbing. A quantitative example from Pará illustrates the process. For the 35 years prior to 1958, Pará's Land Secretariat sold only 384,000 ha of state lands to private individuals. From 1959 until 1963, it sold state land in a near anarchical fashion, in a total of more than 5,646,000 ha. Furthermore, the average size of

the land size per title increased in this same period from 165.5 ha to 3,585 ha. With such large increase in land demand in a area of poor land legal organization, it is not suprising that conflicts over land possession increased dramatically. As discussed in the next chapter, land conflicts have been constant in the most accessible areas of Amazonia ever since, especially as new areas are made accessible by new roads (Carvalho et al., 1979; Foweraker, 1981: 97-103; Hecht, 1982: 73-81, 152; Santos, 1979).

Mining in Amazonia

While the Belém-Brasília was being constructed, in other parts of Amazonia a new economic activity was beginning to take place--mining. The first case of mining in the region on a commercial basis took place in the federal territory of Amapá where, in the mid 1940s, substantial manganese reserves were discovered in Serra do Navio. The Brazilian government gave exploitation rights to Augusto Trajano de Azevedo Antunes, one of Brazil's biggest industrialists who won the bidding for these rights. Through an association with North American Bethlehem Steel Co., Antunes created ICOMI (Industria e Comércio de Minérios S.A.) of which he kept 51 percent share control. Because of strategic reasons during the Cold War period as well as the transportation difficulties in the Suez Canal through which India's manganese reached the west; ICOMI's project received 100 percent financing from the U.S. Export-Import Bank.

Manganese production in Amapá began in 1956 in open sky mines.

To transport the processed mineral from Serra do Navio until ICOMI's port near Macapá, the company built a 200 km railroad. From 1956 to 1979, ICOMI mined 22 of the estimated 43 million tons reserves. Since during the first years of exploitation the best quality ore was extracted, ICOMI built a pelleting plant in 1975 to process the 21 million tons of lower quality manganese left in Serra do Navio. The socio-economic impact of this operation has not been adequately evaluated so far, especially in light of the rate of exploitation and the possibility of the manganese ore's exhaustion in a short period of time. The rise of Antunes' current economic empire has been traced by Evans (1979: 157) to ICOMI's activities in Amapá[20] (Santos, 1981: 86, 94; Bourne, 1978: 142-3; Veja, 1982a).

The second case was that of cassetirite (the ore from which tin is made) in the federal territory of Guaporé. This ore was discovered in the territory in 1952 but mining operation' started only in 1959 with the production of 18 tons. Unlike Amapá's manganese operations, mining in Rondonia[21] was done initially not by a large company but by the activities of hundreds of individual prospectors, known as <u>garimpeiros</u>[22] using small scale and rudimentary technology. Casseterite mining soon became a basic stimulus for the migration of former rubber collectors from other parts of Amazonia and of other Brazilians to Rondonia during these years[23]. By 1968, some 45,000 garimpeiros were producing 2,800 tons of casseterite and by 1970, the last year of free garimpeiro activities in the territory, the production reached the mark of 5,100 tons[24]. Casseterite mining

promoted a substantial increase of Rondonia's population during the late 1950s and 1960s (Filha, 1979; Schmink, Forthcoming).

SPVEA and Forest Research in Amazonia

Although SPVEA helped in some ways to develop these mineral resources, its major accomplishments in fact were few. Its agriculture colonization efforts never went beyond a single nucleus established in 1955 in Guamá, a locality near Belém. SPVEA also helped INPA and Museu Paraense Emilio Goeldi in Belém[25]. Other positive effects of SPVEA includes the construction of the Belém-Brasília highway, the modernization of SNAPP, and the financing of some industrial projects (Mahar, 1979: 10; Moran, 1981: 72; Pompermayer, 1979: 123).

Another positive effect of SPVEA was its support for the study of wood resources of Amazonia. It all began even before SPVEA's creation in 1951, when Pierre Terver, a forester from the recently created United Nations Food and Agriculture Organization (FAO) and responsible for the establishment of this organization in Brazil, presented a report to the Brazilian government after a visit to Amazonia. In this report he mentioned that, despite the large amounts of wood material in the region, there were several difficulties in utilizing it. Terver mentioned the lack of knowledge of the forests, the non-existence of adequate exploitation techniques, the high transportation costs, the existence of only a few saw mills poorly equipped, the marketing difficulties, and finally the absence of financial mechanism to promote wood products industrialization and

marketing. His report was well received in the Ministry of Agriculture which in April of the next year requested FAO technical assistance in dealing with Amazonia's forest situation. That same year a FAO mission of three other forester (Rene-Gachot, Kelvin McGrath and Maurice Gallat) arrived in Amazonia. Their report presented in October of 1953 stressed again the lack of knowledge about the wood resources and their mechanic characteristics, the predatory nature of the current exploitation methods, the scarcity of qualified labor, and the lack of adequate industrial and silvicultural technology. To address these issues, the mission recommended the realization of forest inventories, the creation of training and research centers for forest exploitation and tropical silviculture, and for wood industry.

With the creation of SPVEA that year, the superintendency was entrusted with the task of giving the institutional support for the FAO mission in Amazonia. In 1954, the suggested forest inventory activities began and from them until 1961 some 20 million ha of forests were surveyed and its results published in 10 separated reports. The objective of these inventories performed by teams of FAO experts and Brazilian counterparts through the use World War II aerial photographs and field work, was to collect data on the wood potential of selected forest areas for the eventual development of the forest-based industry. As figure 41 shows, the FAO experts choose to survey areas south of the medium and lower Amazon River between the Madeira and Maracassume River.

The results of these forest inventories indicated the diversity of these forests. Almost 400 tree species with diameter equal or

Figure 41 : Map Showing the Areas in Which Forest Inventories were Undertaken by FAO.

Source: Adapted from Heinsdijk & Bastos, 1963.

greater than 25 cm, belonging to 47 different botanic families, were identified. The researchers in the search for patterns of vegetation, identified 24 different forest types of varying wood production potential. The researchers included in their reporter suggestions for the creation of several forest reserves of which one was accepted and resulted in the creation in 1961 of the Caxiuanã National Forest. This was the first national forest to be created in Amazonia and was set under the administration of the Brazilian Forest Service[26]. Its approximate 200,000 ha are located on the lower Amazon near the mouth of the Xíngu River in Pará (between 1°45' and 2°15' S and 51° 30' and 52° W).

The suggested silvicultural research initiated only in 1955 with the arrival in Amazonia of FAO tropical silviculture expert John Pitt. But it would be only in 1957 that a definitive experimental station was created—Estação Experimental de Curuá-Úna. This station was located in the Curuá-Úna River—a southern tributary of the Amazon River—distant some 110 km by boat from the city of Santarém in Para. John Pitt worked there with very limited human and material resources until 1961,[27] when he was substituted by other FAO experts. Meanwhile, a Nucleus for Industrial Research and Training was created in 1958 in Santarém. There, research was done in wood technology, wood anatomy, physic-mechanic testing, drying, durability and preservation, and forest products. Technical assistance and labor training for wood products industries were also provided by the Nucleus. Collectively, the Nucleus and the Experimental Station became

known as Centro de Technologia da Madeira-CTM (Wood Technology Center)[28]. In both there was a damaging turnover of FAO experts whose effects were mostly felt in Curuá-Úna. There the long term silvicultural and forest management research projects suffered from technical discontinuits since each new FAO expert tried to put their own orientation, methods and priorities by the research. CTM was under FAO technical control until 1968 when the Brazilian-FAO agreement ended and young Brazilian foresters were put in charge of center[29]. (Cavalcanti, 1971: 108-10; Coelho, 1969; Heinsdijk & Bastos, 1963; Pitt, 1969; SUDAM, 1979: 10; SUDAM, 1980: 9-16).

SPVEA's Poor Performance

Several reasons have been listed to justify SPVEA's overall poor performance. Lack of information about the region, inadequate human resources to carry out its planning tasks, are examples but, perhaps, two are seen as the most important ones. First is the lack of funding that SPVEA had assumed would be available given the budgetary committment of the nation towards the region. However, the national Congress cut substantial proportions of SPVEA's earmarked funds sending to the superintendency in average a little over 60 percent of the funds guaranteed by the 1946 constitution. Furthermore, with exception of Pará, legal Amazonian's states and municipalities did not provide their share of the funds. SPVEA did receive substantial amounts of resources to be used by RODOBRAS in the construction of the Belém-Brasília highway by SPVEA had very little control over it. In addition, 75-85

percent of SPVEA's reduced budget were spent through contracts with other public and private organizations in a disperse and piecemeal fashion over which the superintendency also excercised little control.

The second major reason for SPVEA's poor performance is in fact a more basic reason for SPVEA's attitude. The dispersed fashion through which the superintendency spent its reduced budget was the result of its clientelistic policy. That is, the various allocative decisions made by SPVEA were dominated by a need to satisfy the demands of several regional interest groups. By doing so the organization failed to even attempt to pursue its poorly conceived first Five-Year plan (Mahar, 1979: 7-8; Moran, 1981: 72; Pompermayer, 1979: 122-3; Villela & Almeida, 1966: 190-2).

SPVEA's chances of a better performance were certainly not helped by the turbulent early 1960s. President Kubitschek completed his term in early 1961 when he turned power to President elected Jânio Quadros. Quadros had been described as an outsider from the traditional party politics in Brazil. In a move apparantly designed to give him wider new presidential powers, President Quadros submitted his resignation to Congress only 7 months after taking office in belief that it would have no choice but to ask him to remain on his own terms. But congress quickly accepted his resignation. As part of Quadros failed assumptions was the presumption that Vice President João Goulard, a former minister of labor during the second Vargas administration and his political pupil, would be unacceptable to Congress and the military as the next president as the 1946

constitution asked for. In fact, the solution for the Presidential succession debate that followed Quadros'[30] resignation, lasted 13 days and resulted in a compromise solution which included constitutional changes. On September 7, 1961, João Goulard was sworn in as Brazil's president, but, unlike former Brazilian presidents, he was to operate in a parliamentary system. For the next months Goulard maneuvered carefully to regain full presidential powers which he accomplished fourteen months later in January 1963 by winning a popular approval in a national plebiscite (Skidmore, 1967).

During Goulard's tenure, important new policy instruments were given to SPVEA. They were part of a fiscal incentive program originally designed to be used in the northeast region by SUDENE to promote a development model of import substitution industrialization[31]. In May 1963, this program was extended to Amazonia (CFI, 1969: 181; Lima, 1971: 30; Pompermayer, 1979).

But this program would only become operational after the 1964 military revolution which had put an end to the Brazilian democratic experience initiated in 1946 with the fall of Vargas and the election of Dutra[32].

Notes for Chapter IV

Section IV.1

1. Up to this point, this section has been based on Poppino, 1968: 40-4; Simonsen, 1969: 326.

2. The party was formed by 200 spaniards, horses, 4,000 Indians, arms, supplies, almost 4,000 swine heads and many llamas carrying part of this baggage. Many have rewritten the story of this expedition but one of the most complete of these works is that of Medina, 1934. This summary presented is based heavely on the dissertation by Breymann (1950) and to a lesser extent on Furneaux (1969).

3. The cinnamon trees were considered to be inaccessible, too few, and of inferior quality making it impossible to have them transported to Quito or Lima let alone Europe (Breymann, 1950: 36).

4. See Breymann, 1950: 39-47 for Pizarro's and Orellana's accounts of the events.

5. Besides the vividy description of this encounter by Carvajal, the existence of women worries was also reported by several other travellers, including, Sir Walter Raleigh and Columbus himself. Others in later centuries also confirmed their existence which was finally negated by the end of the last century (Simonsen, 1969: 306).

6. For a period the name of the river was Orellana in honor of its "discover", but soon the legend of the Amazons dominated and prevailed.

7. Orellana before going to Spain stoped in Lisbon where the Portuguese unsucessfully tried to obtain his cooperation to explore the Amazon River for that country.

8. After much suffering, Pizarro returned to Quito by land, arriving there with just a faction of his men.

9. Castelo Branco had originally named the area Feliz Lusitania, but soon the name Grão-Pará was adopted.

10. Until 1715 Piauí was part of the captaincy of Bahia, and between this year and 1758 it was part of the Maranhao and Grão-Pará State when it became an independent captaincy. On the other hand, Ceará was part of the new State from the beginning, but it passed to the jurisdiction of Pernambuco in 1656. Maranhão, Pará, and Amazonas were always part of the new state (Kiemen, 1954: 27).

Section IV.2

1. In these first years at least two smallpox epidemics (1616, 1621) broke out causing many deaths among the Indians (Kiemen, 1954: 17; Meggers, 1971: 151).

2. Raposo Tavares has been reported as having reached the Madeira river before in 1626, but this has not been confirmed (Breymann, 1950: 171). For more details on various aspects of the Guaporé-Mamoré-Madeira route from Mato grosso to Belém and Lisbon, including its geopolitical, social and commercial importance see Davidson, 1970.

3. When Portugal was associated with Spain, it was considered by the tradicional Spanish enimies--England, France, and even Holand, its former partner in the marketing of the Brazilian sugar production in Europe--also as their enimies. During this period Portugal suffered great losses in terms of colonies, ships, and hence of its trading business (Simonsen, 1969: 354-5n, 362).

4. These post-Babylonian Captivity dificulties led Portugal to seek alliance with Great Britain. By the accords of 1642, 1654, and 1661, Portugal obtained British support in defending the colony, promisses, and political guarantees, and in exchange it gave considerable economic privileges including: freedom to commercialize with the Portuguese colonies, control over the tariff that commodities imported from England itself should pay, and others. By doing so, Portugal became an English vassal (Furtado, 1969: 36-7).

5. Cacao was introduced in Europe by the Spaniards who found the Mayans using a drink which they prepared from cacao seeds obtained from their tree plantations. Cacao trees are native of the Amazon region and when they were discovered there and the demand for cacao increased in Europe, it became one of the most important forest products exported in that period. Cacao plantations in Amazonia initiated in the 1700s (Richardson & Stubbs, 1978: 211; Gross, 1969: 273).

6. Cassava, sugarcane, rice, cattle, fish, coffee, cotton were also produced but mainly for domestic consumption and did not represent significant export items.

7. By the 1700s, the once populous lower Solimoes had been substantially reduced. Expeditions to Rios Tapajós, Madeira, and Negro were undertaken in the first fifty years of the 1700s and were responsible for this decrease. Some Indian tribes discovered that one of the ways to avoid war was to capture other Indians themselves and exchange them with the Portuguese traders. This phenomenom increased substantially the level of conflicts between Indian tribes (Sweet, 1974; Gross, 1975: 212).

8. In 1703 a new accord between Portugal and England was signed. In exchange for continuing British support to Portugal, Lisbon renounced to all manufacturing development in its land possessions. This and previous accords gave england the advantages to be obtained from the gold production in Brazil (Furtado, 1969: 38).

9. This Treaty was estabiished while Portugal was still under the command of King João V who died six months later (July, 1750). A new king came to power, and with him Sebatião José de Carvalho e Melo, later known as Marquis of Pombal and who became the virtual dictator of Portugal (Boxer, 1962: 293).

10. Up to this period, money was virtually unknown in the colony and its use was officially forbidden at times. During these first decades several goods were used in exchange. Among the principal ones were: cotton cloth, sugar, tabacco, cacao, vanilla. Sugarcane liquor was also used, especially when trade involved Indians, although their wages were officially set in cotton cloth (Boxer, 1962: 275-7; MacLachlan, 1973: 205; Gross, 1969: 270; Simonsen, 1969: 312).

11. Pombal separated the captaincies of Grão-Pará and Maranhão administratively in 1774 (Vianna, 1967: 183).

12. See Santos, 1980: 32-3.

Section IV.3

1. The name <u>seringueira</u> is derived from one of the Indian rubber products, namely serynge--in portuguese <u>seringa</u>.

2. As mencioned above, during most of the colonial period, land was given away as royal grants, <u>sesmarias</u>. They were in large in size--varying from 16.7 to 50.1 square miles--and were given as incentive for agriculture production to initially anyone who claimed to have the means and willingness to use the land. Squat was illegal but not uncommun during the period. With the end of the colonial period, the Council of Appeals at Rio de Janeiro ended the <u>sesmaria</u> system until the Constituional Assembly decided on how the Crown land should be disposed. Although there were various law propositions for the next decades, only in 1850 a new law was enacted and four years later it was regulamented. Through this law, squatters' rights became legalized (Dean, 1971; Valente, 1983: 356-73; Weinstein, 1983a:137f).

3. Despite the fact that the 1824 Constitution asserted that the Empire would be divided into the existing provinces, when the new provincies' presidents were nominated, Alto Amazonas' was not included. It then became once again a comarch subordinated to Pará. This situation was to change only in 1850 when Pedro II created the largest province in

the country but with population of less than 30,000--Amazonas. The new province's capital was to to be Barra do Rio Negro, which in 1856 became known as Manaus. These institutional changes brought greater administrative freedom to the province, with positive reflexes on the local economy (Oliveira, 1983: 219-20).

4. According to the practices and laws of the period, a seringalista could secure control over a peace of land by purchase, squatter's right, or force (Resor, 1977: 346).

5. Itinerant traders known as regatão--literally, bargainer--did exchange occasionally directly with the tappers either for money or bater. This was obviously without the permission of the patrao. Initially these traders were Portuqueses or cablocos, but later Sirians, Lebaneses and Jewishes dominated this business (Oliveira, 1983: 235-7; Weinstein, 1983b: 21-2).

6. From the portuquese verb aviar, meanning in Amazonia the supply of goods on credit (Santos, 1980: 159).

7. Droughts in Northeast Brazil in the first half of the 1800s occured during the following years: 1808-9; 1824; 1835-7; 1844-5 (Cunha, 1967 cited by Reis, 1980: 98f).

8. Other reasons listed by Santos (1980: 108) are the transport subsidies offered by Amazonian governments and the proximity of the two regions.

9. These negociations were based on this principle as it had been also used in 1851 in a treaty between Brazil and Peru by which it was aggreed that all territorial question between them should be settled on the basis of this principle (Tambs, 1974: 72, 74).

10. The Madeira-Mamore railroad had initiated in 1872 when an American, Colonel George Church, obtained permition with the Bolivian and Brazilian governments to construct it. He had seen a good opportunity to make profit from an investment project which would connect the rubber producing areas of Bolivia and north Mato Grosso--a Brazilian state--with the fluvial system which would take the black gold to Manaus and Belem. A series of rapids, as has been mentioned when discussing the Madeira-Mamoré-Guaporé transportation system during the colonial Pombal period, made navigation impossible in that stretch. Church contracted construction with a British firm and later with an American firm but both were unable to even have a significant start in the job. Working under problems with Indians and diseases besides the operational difficulties of working in a tropical rain forest, resulted in only 7 km by 1879 out of a total railroad length of 364 km. Many northeastern Brazilians, Indians, North Americans, Irish, Italians lost their lives during those few years. With those two failures, Church was unable to pursue his dream any further and lost his consession. As

part of the Treaty of Petrópolis, construction resumed in 1907 and after 5 years of hard work, with thousands of men--due to high labor turnover rate--and the use of malaria prevention measures learned from the Panama Canal building experience, the work was completed. Ironically, the Madeira-Mamoré railroad connecting the cities of Porto Velho and Guajará-Mirim was inaugurated in 1913; exactly the same year when rubber prices started to decline signing the end of the rubber boom. The railroad was never fully used. In the late 1960s, it was used to support a road construction between Porto Velho and Guajará-Mirim, duplicating its trajectory. In 1972 it seased to function. A few years later, a 30 km streatch was reactivated for touristic purposes (Fleming, 1969: 160-5; Mesquita, 1977:292; Oliveira, 1983: 229-30; Santos, 1980: 93-7).

11. The Bolivian Syndicate had been ended a little earlier that same year, with Brazil paying the British-American group a sum of money (Santos, 1980: 205). In 1906, Army Colonel--later Marchall--Candido Mariano da Silva Rondon accepted the task of connecting telegraphic lines from Cuiaba in Mato Grosso to the recently created Acre Federal Territory. This famous Brazilian geographer and humanist spent 8 years to complete his task which amounted to the construction of 2,268 km of telegraphic lines. In this process, Rondon discovered 15 new rivers, made pacific contacts with several Indian tribes and established telegraphic posts which later would develop into small cities like Pimenta Bueno and Vilhena. The trail he opened along the telegraphic lines was used later by southern Brazilians to reach the Guaporé and Mamoré valleys and also served roughly as the basis for the construction of a road connecting Porto Velho to Cuiaba in the 1950s (Mueller, 1980: 145; Ribeiro, 1977: 111-5).

12. This concept would be called upon again during the 1970s in the Transamazonica highway colonization scheme.

13. The first highway built in Zona Bragantina date from the 1940s. With the improvement of the highway network, the Belém-Bragança Railroad was finally terminated before the end of the 1960s (Mesquita, 1977: 292).

14. Free translation by the author.

15. The issues of property rights of genetic resources, the international implications of transfers of these resources among countries, and related topics are still of concern nowadays. In fact, in a recent meeting of the United Nations Conference on Plant Genetic Resources in Rome, Italy, Third World nations started to voice publicly their concern over the matter (Paul, 1984: 23; Walsh, 1984: 147-8).

16. In the 1950s, Brazil became a net importer of natural rubber and in 1980 it produced 27,813 tons which represented less than 1 percent of the world total natural rubber production. By 1978, Malaysia ,

Indonesia, and Thailand were the major natural rubber producers and together they were responsible for 90 percent of the world total exports of this product. They three countries also retain more than 85 percent of the world's natural rubber plantations (Goering et al., 1982: 11f, 55; IBGE, 1981: 406; Poppino, 1968: 144; Wanigatunga, 1983: 141).

17. Pará's usufruct land concession law was passed in 1925 (Oliveira, 1983: 251-2).

Section IV.4

1. Fonseca (1970:48) also reffers to high taxes in the United States as a basic reason for Henry Ford's decision to sell Belterra and Fordlândia.

2. Pepper production in Tomé-Açú was done on a communal basis, which certainly helped to deal with the labor problem found elsewhere in Amazonia. However, during the harvesting period--until recently a very labor intensive task--outside help was usually obtained (Cardoso & Muller, 1977: 48; Nelson, 1973: 239).

3. In July 1978, eight South American countries signed the Treaty for Amazonian Cooperation. This treaty was promoted by the Brazilians and drew from many of the ideas first developed in the Vargas era (MRE, 1983; Ostrander, 1981).

4. Although half of its 28 articles related to rubber, these accords also dealt with other Brazilian products such as cacau, babacu, rice, coffee, and iron ore. During this period Brazil also obtained United States capital equipment to built its first large integrated steel mill at Volta Redonda (Salgado, 1978: 47; Fonseca, 1970: 138-40).

5. Through the years of the rubber boom and thereafter, the Amazonian aviamento system was frequently criticized in other parts of Brazil. The Amazonian elite, as previously mentioned, depended on this system and tried to defend it. Although these amazonians wanted federal government intervention in the region, they were very concerned about the possibility that such intervention might imply a change of this method of production, financing, and marketing. This concern grew with the advent of the Estado Novo and its authoritarian and centralizing principles. Their preferred alternative was essentially dependent on higher prices in order to generate some profitability to the aviamento system. Amazonians, however, were not represented during the negotiations of the Washington Accords. Even if they had been, it is unlikely that they would be succesful in affecting the final scheme since the aviamento system was very unpopular with southern decision

makers (Galey, 1977: 35-7; 54).

6. Amazonian merchants became allarmed when BCB bypassed them in directly making loans to and purchasing rubber from producers. But the new arrangement actually brought unprecedented benefits to these merchants. These included immediate cash payments for the supplies they sold as well as bank loans for commercial use (Galey, 1977: 70-1).

7. In accordance to Brazilian aspirations to expand the objectives of the Washington Accords so that it would have a long term impact on Amazonian development, U.S. funds were also used to implement the Instituto Agronomico do Norte-IAN (Agronomic Institute of The North). This institute had been created by Vargas in 1939 to study the several problems related to the use of Amazonia's natural resources. However, it was only after the Washington Accords that IAN was actually implemented although this time it was supposed to concentrate its efforts on studies of the seringueira. After the Ford Motor Co. sold Belterra and Fordlândia to the Brazilian government, IAN became also responsible for their administration and created a experimental station there (Oliveira, 1983: 264; Salgado, 1979: 49; Wagley, 1953: 290).

8. The rubber production figures for the period varied from author to author, although all of them showed the same trend. For alternative production figures see: Fonseca, 1970: 140; Galey, 1977: 60; Mahar, 1979: 5-6; and Oliveira, 1983: 266.

9. The 1946 Constitution defined a new perspective for regional planning in Brazil. Besides the Amazonian development commitment, the law makers also stipulated funding for a plan for Northeast drought defense and another plan for the economic development of the São Francisco Valley, also in Northeast Brazil. Although the constitution mentioned these three plans, they did not exist in paper (Costa, 1971: 41, 258).

10. Law no. 86 of September 8, 1947 regulated by Decree no. 23,990 of October 31, 1947(Fonseca, 1970: 42-3; 225-7).

11. This task of BCB would in fact be kept exclusively to this bank and its substitutes until 1966(BASA, 1967: 205-26 cited by Mahar, 1979: 31f).

12. The word "hileia" means forest in greek and was apparently first used to discribe the Amazon Valley by Alexander von Humbolt (Galey, 1977: 6).

13. The Conselho Nacional de Pesquisas has currently a new name: Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technologic Development), although it still keeps the old acronym CNPq.

14. Maranhão to the west of meridian 44°; Goiás north of parallel 13°; and Mato Grosso north of parallel 16°. See article 2° of Law 1806 of February 11, 1953.

15. As has been discussed in the next chapter, this objective has been present in a way or another in almost all governmental action ever since the first portuguese arrived in Amazonia.

16. SPVEA had chosen some 16 growth poles into which it would concentrate its efforts (Katzman, 1976: 450-2).

17. Investments in natural resources represented less than 47 percent of the total actual expenditures of SPVEA's First Five-Year Plan (Mahar, 1979: 8-9).

18. The idea of such move can be traced to the colonial period, but it was in the mid-1800s that Brazil's central plateau was first suggested to be the site for a new capital. The text of the 1891 Constitution included a mention of the new capital which was repeted directly or indirectly in the following constitutions. To commemorate the first centenary of Brazil's independence from Portugal, a cornerstone was laid at a location in fact quite close to Brasilía's actual center. A series of studies to identify the precise site for the new capital were undertaken after 1946 which resulted in kubitschek's final decision in 1956 (Pinto, 1960: 335-8).

19. With the 1961 change in president, RODOBRAS was abolished and the Belém-Brasília construction and maintainance seised. In 1963 RODOBRAS was reinstalled and these road activities were resumed (Katzman, 1977: 47).

20. In fact, Antunes has looked for alternative investment in Amapá. After trying different economic activities, and perhaps influenced by American millionary Daniel K. Ludwig and his Jarí pulp project, Antunes--a close friend of Ludwig--created the Amapá Florestal e Celulose SA-AMCEL for the formation of artificial forest plantations to be eventually utilized in a possible pulp industry. Pine plantations on Amapa's cerrado (savanna like vegetation) areas initiated in 1977 (Dube, 1980: 149-50, Bourne, 1978: 143; McDonald & Fernandes, 1984). More on the Jarí project will be discussed later in appendix 4.

21. The name of the Guaporé territory was changed on February 17, 1956 by Law no. 2,731 to Rondonia as a tribute to Marshal Candido Mariano da Silva Rondon. Rondon, as discussed before, was a famous Brazilian humanist whose works with Indians and as a geographer has gained him international recognition (Ribeiro, 1977).

22. For more on the garimpeiros and their importance as mineral producers in Brazil see Salomão, 1982 and Schmink, forthcoming.

23. Brazilians coming from south Brazil would more often use the precarious trail originated from Rondon's telegraphic line built at the beginning of the century. The federal territory administrators had improved the trail to a road status from Porto Velho to Ariquemes already by 1945. A few years later it would pass through Pimenta Bueno, reached Vilhena, at the Rondonia's southern border and finally became a precarious road connection with Cuiaba in the state of Mato Grosso in 1960. Ariquemes, Pimenta Bueno and Vilhena were originally telegraphic posts (INCRA, 1984: 3, 10; Mesquita & Egler, 1979: 68; Mueller, 1980: 145).

24. In 1970 the Ministry of Mines and Energy prohibeted garimpeiro activities in casseterite mines in Rondonia and gave exploitation rights to four major companies (Filha, 1979). This generated unemployment and rural to urban migration (Schmink, forthcoming).

25. In INPA, SPVEA helped to created a pulp and paper laboratory and a forest resources center but both had a very slow start. SPVEA also helped the Museu Paranaense Emilio Goeldi which is the oldest research institutions in Amazonia. The roots of this museum can be traced to 1866. It achieved an explendor period from 1894 till 1914 during the rubber dominated economy period. Emilio Goeldi was one of the most successful director of the Museum during this period what resulted in a tribute to him in 1931 by giving his name to the museum. From 1954 until 1984, the museum was under INPA's supervision when it acquired independent relation within CNPq. The museum does research in archeology, antropology, botany and zoology (Batista, 1971; Higuchi, 1981, and other articles in <u>Acta Amazonica</u>, vol.11, no.1 (Supl.), 1981).

26. The Brazilian Forest Service was created during the Old Republic period in 1921 but it would be regulamented only 4 years later. In 1934, Vargas approved Brazil's first Forestry Code, which for the next 30 years would be the basic forestry legislation of the country. To monitor the execution of the forestry code, the Forest Service was reorganized in 1938. During the first decades of its existence, the Forest Service was most concerned with botanical research, the promotion of tree plantation in private lands, and with the administration of National Parks--the first was created in 1937 in Rio de Janeiro--and Forestry Horts. The concerns of the Forest Service in terms of promoting forest-based sector development were very limited. In fact, Vargas even preferred to create a special federal institute to deal with the various developmental aspects of Paraná Pine (<u>Araucaria angustifolia</u>) in 1941, than to adjust the Forest Service mandate. This was also a reflection of the mood of the period when Vargas created a series of federal institutes for each of Brazil's major economic products. For several decades, paraná pine production was one of the most important economic products from south Brazil where most of the forest-based industry of the country is still concentrated (APEC,

1981: I-11; Andrade, 1950: 170-85).

27. Pitt published his final report for FAO in Inglish that same year while its portuguese version would appear only 8 years later in 1969 (Coelho, 1969).

28. Currently CTM is a descentralized unit under the supervision of the Department of Natural Resources of SUDAM, the agency which substituted SPVEA after 1966. See next chapter.

29. Undergraduate education in forestry began in Brazil only in 1960 also with the help of FAO and the first undergraduates appeared in 1964.

30. The brief tenure of President Quadros in power had an interesting footnote for nature conservation in Brazil. Quadros created 6 National Parks--none in Amazonia--and 9 Forest Reserves almost all of them in Amazonia and many in a single day (Cavalcanti, 1971). These Forest Reserves comprise a total area of some 17 million ha. It should be noticed, however, that these forest reserves were created in areas of very difficult access and that the Brazilian Forest Service practicly ignored their existence. Indeed, as discussed above, the new Forest Code established in 1965 does not even mention this type of land use.

31. The Superintendencia de Desenvolvimento do Nordeste-SUDENE (Superintendency for Northest Development) was created by Kubitschek in 1959. In late 1961, during the Goulard government, the program of fiscal incentive was first introduced in Brazil to promote regional development.

32. It was during Goulard's administration that the federal territory of Acre became state and the name of the federal territory of Rio Branco changed to Roraima.

CHAPTER V

The Post-1964 Revolution Period: Major Changes

V.1 Estatuto da Terra and Operation Amazonia

The period after the 1964 revolution has been a phase of fundamental changes in the Brazilian society. These changes were possible in a short time period because of the increasing use of authority by the new regime until the mid 1970s.

General Humberto de Alencar Castelo Branco was selected by his military fellows to become the first president of the March 31, 1964 revolution. Castelo Branco was sworn in office on April 15 and went on to promote substantial change in Brazilian society only comparable in its impact to Vargas changes of the 1930s. But this time their impact on Amazonia would be much greater.

Estatuto da Terra

One of Castelo Branco's first actions as president was to approve a land reform and rural development law addressing issues which had not been the subject of substantial regulation since law 601 of 1850. The Estatuto da Terra (land statute) was approved by congress on November 30, 1964 as Law no. 4,504. This document was in fact the result of debates which had started years before the revolution and which culminated during the Goulard administration[1]. This law has

been seen by Cehelsky (1972: 246) as a popular measure of the revolutionary government in a series of unpopular ones necessary to increase public support for its new economic program, or as she puts it: "(The Estatuto da Terra) was the one sweetmeat the masses could be offered in an otherwise bitter revolutionary meal." This document has been the basis of all agrarian policy in Brazil since then and because of this and of its impact on Amazonian development, it will be discussed in greater detail below.

The Estatuto da Terra is an extensive and detailed document comprised of 128 articles. It has its basis in the principles of social justice and social function of land properties. The concept of social justice is one of the basic principles of the economic and social order of Brazil as defined by the constitution which was adopted in the last months of the Castelo Branco administration in early 1967. Like the concept of public interest in the public policy literature, social justice is also a difficult term to define. According to the 1967 constitution, social justice should be based, among others, on the principle of the social function of properties. As interpreted by the Estatuto da Terra, a land property is performing its social function when (a) it promotes the welfare of its owner, of the workers who work in it and of their families; (b) it keeps satisfactory productivity levels; (c) it assures the conservation of the natural resources; and (d) the laws regulating the relationships between land owners and rural workers are observed (Art. 2nd, 1st paragraph).

In order to promote the social function of land properties, the

Estatuto da Terra was conceived in two main policy groups--agrarian reform and rural development. Agrarian reform was seen as a means to promote social justice, appropriate land use, the welfare of rural workers, and the economic development of the country through the gradual elimination of economically inefficient minifúndio and latifúndio in selected priority areas. A basic innovation of the Estatuto da Terra was that it allowed the public sector to expropriate land for the purpose of land reform[2] payable in bonds redeemeable within twenty years. A constitutional amendment was necessary to give legality to this aspect of the Estatuto, since the 1946 constitution determined that there must be prior indemnification in currency, which in the past had substantially limited the possibilities of expropriation. To implement the agrarian reform part of the Estatuto da Terra, the Castelo Branco government approved the creation of the Instituto Brasileiro de Reforma Agrária-IBRA (Brazilian Institute for Agrarian Reform) under the Ministry of Agriculture[3].

The second policy group of the Estatuto da Terra was concerned with the promotion of rural development. The basic policy instruments to be used for this promotion were the use of (1) rural land tax (Imposto Territorial Rural-ITR)[4], (2) colonization (which can be executed by the government and therefore named official or by the private sector), and (3) technical assistance and rural economy protection (which included: the production and distribution of seeds and seedlings; promotion of better animal stocks, agrarian machinary use, cooperativism; financial and credit assistance; marketing

assistance; promotion of agricultural products industrialization, rural electrification and other infrastructure; and agrarian insurance). To implement these activities another federal organization was created, the Instituto Nacional de Desenvolvimento Agrário-INDA (National Institute for Agrarian Development).

The Estatuto da Terra also kept the concept of right to land through its appropriation, know as direito de posse. This same concept had been used in 1850 in law 601, as discussed above, but its origin can be traced to the criterion by which land disputes between the Portuguese and Spaniards were resolved in colonial times: uti possedities de facto. It states that a squatter or posseiro, who has lived on unclaimed public land (terra devoluta) and cultivated it (cultura efetiva e morada habitual) for at least one year and one day has preference to acquire[3] that land with a size of a rural module[4]. If the posseiro has fulfilled the living and cultivating condition for more than 10 consecutive years he has the right to the land title (articles 97-102).

This last provision of the Estatuto da Terra has been of a fundamental importance for most of the events which have taken place in the region especially since its accessibility increased with the opening of the Belém-Brasília Highway. For the forest-based sector its impact has been most dramatic. The basic condition for the granting of the direito de posse, i.e., cultura efetiva e morada habitual, has been interpreted as meaning any form of land use except forestry. Forested land usually is considered as idle and therefore should be

converted to other uses. That is to say that for a posseiro to demonstrate his rights to a piece of land, he has to deforest it. In addition, the posseiro is likely to obtain a right to larger land tracks the larger the area he has deforested. In fact, it has not been unusual to observe posseiros claiming land that has been deforested and planted with pasture--the simplest and cheapest culture acceptable to qualify as cultura efetiva but with no cattle. This behavior is not limited to the small farmer trying to obtain a piece of land for his survival, but it is also shown by large cattle farmers and other land grabbers who, in the race to get land for speculative reasons started with the opening of the Belém-Brasília Highway, rapidly remove the tropical forest to obtain legal legitimacy. This incentive to deforest has become one of the most important causes of deforestation in Amazonia[7] (Cehelshy, 1972: 247; Fearnside, 1981:113; Foweraker, 1981: 112; Lunardelli, 1983; Valente, 1983; Yokota, 1981: 6-8).

Other consequences of the direito de posse provision include the increase of land invasion and consequent conflicts among posseiros, Indians, land grabbers, and legal land owners (since public and private lands are not easily distinguishable), frequently with fatal results. Another consequence has been the development of the so called industria da posse. In this case a "professional" posseiro takes possession of a piece of land, clears it, and with the sole objective of a fast profit, "sells" his direito de posse to other, later arriving, posseiros or demands compensation from the legal owners and moves further into the frontier repeating the process (Foweraker, 1981;

Ianni, 1979a; 1979b; 1981; Martins, 1980; Moran, 1983: 302; Poelhekke, 1982). More about those consequences will be discussed below.

Operation Amazonia

Amazonia was also high on the priority list of the military leaders who took power in 1964. Just seven days after the revolution and even before Castelo Branco's nomination, the new central government interviened in SPVEA. An army general was appointed to head the organization and a commission was established to undertake an administrative inquiry to determine the extent to which SPVEA was affected by personalistic administration, corruption, and the extent to which its decisions were dependent on local and clientele interests. Two months later, the inquiry commission considered the superintendency purified of its former defects and fit to undertake its tasks.

The new central government, however, decided in 1965 to remove SPVEA and other regional agencies from the direct control of the presidency as suggested by a special commission entrusted with the task of improving regional agencies in the country. A new Ministério Extraordinário para a Coordenação de Agências Regionais-MECOR (Extraordinary Ministry for the Coordenation of Regional Agencies) was created that same year to perform that task. (Pompermeyer, 1979: 167-8; Salgado, 1979: 94).

During the rest of 1964 and until 1966, SPVEA continued its fiscal incentive policy initiated during the Goulard administration by promoting import substitution industrialization in Amazonia. Firms

with 100 percent Brazilian capital were allowed to use tax-credit funds to finance up to 50 percent of their total investment cost in industrial projects in Amazonia. Within this strategy, forest-based industries were well seen, and by 1965, 33.4 percent of SPVEA's industrial investment was in wood industries (Lima, 1971: 33-4; Mahar, 1979: 92; Pompermayer, 1979: 168; Villela & Almeida, 1966: 190-1).

However, the import substitution industrial policy of SPVEA to promote Amazonian development was about to be changed. Already in 1965, Castelo Branco charged a 5-member special committee (Grupo de Estudos para a Reformulação da Politica Econômica da Amazônia) to study and propose legislation for a new development policy to promoted a greater efficiency in the regional planning apparatus and an increase in the role of the private sector in the region's development. Technical considerations in this new policy were to take precedence to clientele-oriented decision-making (Mahar, 1979: 10-11).

By late September 1966, the results of these studies were starting to be felt. First BCA was abolished and in its place the Banco da Amazônia S.A. -BASA (Bank of Amazonia) was created by Law no. 5,122. Like the import substitution industrialization strategy used by SPVEA, BASA was also designed in a structure similar to that of the Northeastern Development Bank which operated as a development bank for that region and as a financial agent for SUDENE (CNI, 1969: 198).

A month later, however, the most important part of the Castelo Branco strategy for Amazonia was unfolded. This strategy was included in two basic laws approved on October, 27th. These laws, which

included changes in the institutional arrangement of the region as well as the fiscal incentive program, were approved by Castelo Branco as part of his new Amazonian development policy known as Operação Amazônia (Pompermayer, 1979: 125, 169).

Law no. 5,173 deals basically with (1) the redefinition of the Plano de Valorização Econômica da Amazônia-PVEA; (2) the transformation of SPVEA into a new organization, the Superindência de Desenvolvimento da Amazônia-SUDAM (Amazonian Development Superintendency); and (3) the creation of the Fundo para Investmentos Privados no Desenvolvimento da Amazônia-FIDAM (Fund for Private Investments in Amazonian Development) to be applied by BASA.

The objective of the PVEA was to promote the self-sustained development of the economy and the social welfare of Legal Amazonia* in harmony and integrated in the national economy. PVEA should consist of multiannual plans were to be approved by the president and revised annually. The plans should include the description, objectives, costs, annual budget, and the sources of funds for each designed program.

Law 5,173 also defined the basic orientation to be used in the elaboration of these plans. The basic orientation was layered out as a list of 13 items. They defined the role of the government as planning, labor training, research of natural resources and their economic potential and the provision of infrastructure. These government activities should be concentrated at selected growth poles and international frontier areas (reflecting the traditional geopolitical

concern) around which the private sector should be stimulated to undertake agriculture, livestock and fishery activities to support the population centers. But most important, the government would provide fiscal and credit incentives to attract national (from the region itself in the form of reinvestment and from other parts of the country) and foreign capital[10] to be used not only in industrial investment (as during the SPVEA years) but also in agriculture cattle raising, marketing, and the provision of profitable basic services. The basic orientation also addressed the traditional Amazonian labor problem by including a policy to promote the immigration of nationals from other parts of Brazil with "excessive" population and of selected foreigners. A special item dealing particularly with the forest-based sector was also included as a basic orientation. By this orientation, wood production should be based on managed forests (including silvicultural techniques and improved- productivity technology) provided that the "extractive economy" could not be substituted for other more profitable activities[11].

To elaborate, control, and execute the PVEA, SUDAM was created under the Ministry of the Interior[12] to replace SPVEA. SUDAM would also coordinate the actions of other federal government agencies in the region and could contract specific tasks with other public and private

organizations. One of the most basic tasks of SUDAM was to analyze and approve private sector projects applying to benefit from the fiscal incentives program to be described below. Article 10, sole paragraph, states that SUDAM should give preference in its project selection activities to industrial projects which used regional raw material. The resources available for SUDAM would come basically from the Union budget and from fees charged for fiscal and credit incentive project analysis.

The third component of Law 5,173 was the creation of FIDAM. This credit fund was constituted basically with resources from (1) budget allocations from the Union, (2) the sale of "Amazonian securities" issued by BASA, (3) fiscal incentives resources not used within the legal time requirements, (4) the BCA's Fundo de Fomento da Produção, and (5) the net revenue of its own operations.

FIDAM resources would be used by BASA to provide credit to the private sector for investment projects considered by SUDAM as priority for Amazonian development. These resources could also be used by the private sector to finance research related to the use of the region's natural resources or to agriculture production. It should be noticed

that the Union budget allocation to FIDAM was legally earmarked to be used for agriculture credit by the also recently created Nacional Monetary Council—a policy which may have been appropriate for the rest of the country but of arguable value for the ecological conditions of Amazonia.

The second group of subsidies has had a major impact in the region. Its first part allowed any corporation registered in Brazil to deduct up to 75 percent of their income tax liability if it were invested in BASA securities. The second and most important part allowed the deduction of up to 50 percent of the tax liability of these corporations[14]. The funds so saved would have to be deposited in a blocked account in BASA and could only be used to invest in projects located in Amazonia legal and approved by SUDAM within a 2 year period[15]. These funds could not be used to finance more than 2/3 of the total project cost although the remaining capital could be financed by the also subsidized credit funds of BASA or other lenders[16]. These projects did not need to be only industrial projects as before, but now they could also be agricultural, cattle raising, and basic services (i.e., colonization, energy, transportation, communication, tourism, education, and public health projects).

The project where the tax credit funds were to be invested in could be the corporation's own project or a third party project. Any corporation, regardless of whether or not it participated in the deduction of its own income tax in the program, could have investment projects examined and approved by SUDAM and, thereby, become eligible reinvested in the corporation. This law also provided (1) export tax exemption for selected products produced in Amazonia, (2) import tax and fees exemption for non-obsolete machinery and accessories not found in Brazil to be used in approved projects, and (3) exemptions of other minor federal taxes and fees.

Law no. 5,174, the second major legal document of Castelo Branco's <u>Operação Amazônia</u>, regulated the fiscal incentive program to promote development in Amazonia. These incentives were divided into two major groups of subsidies. The first type was the exemption of various federal taxes and fees that existing or new corporations in Amazonia legal would have to pay. The most important of those exemptions was the one related to tax on income obtained by investments made in the region and considered by SUDAM to be of interest for the region's development. This exemption would be of 50 percent of the tax liability until 1982 for existing enterprises or 100 percent exemption until 1971[13] for new enterprises or existing ones which expended or modernized their production capacity. The resources so saved should be

to use the tax credit funds. This provision resulted in the creation of many new corporations specialized in generating projects and competing for the tax credits funds. Private brokerage houses, which charged increasingly large fees, also appeared due to this provision to match the tax credit funds available from one corporation with the approved projects of third parties, especially after the policy changes of 1970 yet to be discussed (Mahar, 1979: 96-7; Pompermayer, 1979: 171). As discussed below, this situation would only be corrected with the creation of a special fund, Fundo de Investimento da Amazônia-FINAM, (Investment Fund of Amazonia), in late 1974 where all tax credit funds were pulled together.

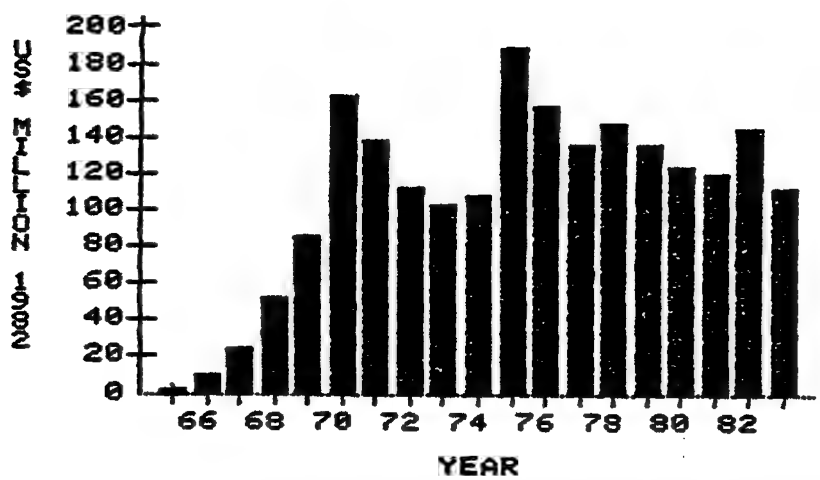
While BASA handled the money, SUDAM was responsible for the analysis and approval of the investment projects. Article 73 of Decree 60,079 of January 16, 1967, established that first priority for SUDAM approval would go to those projects with one or more of the following characteristics: (a) promoted the greater social and economic occupation of Amazonia; (b) were more labor intensive; (c) used regional raw material to produce goods and services for import substitution from national or foreign sources, or for export; and (d) were located in less developed areas as defined by SUDAM. These criteria indicated old concerns with sovereignity of the region and the current ideology that security of Amazonia was derived from national and regional economic growth and that development would help to cement national sovereignity (Pompermayer, 1979: 125).

With this framework basically set up by Laws 5,173 and 5,174,

Castelo Branco underwent a major effort to consult the private sector entrepeneurs by promoting and debating the new framework. For this, a week-long meeting of public officials (besides Castelo Branco himself and several of his ministers it included the governors of all Amazonian states and federal territories as well as the governor of São Paulo state), more than 200 South Brazil business leaders, and technicians was undertaken. The "1st Reunião de Incentivos ao Desenvolvimento da Amazonia" took place from December 3 to 12, 1966, inside the ocean liner Rosa da Fonseca in a cruise on the Amazon River initiated in Manaus and which ended in Belém. This official meeting represented one of the first examples of the kind of consultation between public officials and private sector enterpreneurs which would become a frequent feature of the process of making and implementing public policy concerning Amazonia of the post-1964 revolution period (CFI, 1969; Pompermayer, 1979: 175-80).

The very favorable fiscal incentive program terms were very effective in capturing and transfering capital from Southeast Brazil (mostly São Paulo) to Amazonia. The tax credit resources deposited in BASA rose from US$ 56.6 million in 1966 (2.6 times more than in 1965) to US$ 201.5 million in 1970[17]. However, during these first years the annual resources commitments by SUDAM in approved projects were substantially lower than the resources available leading to an accumulation of uncommitted resources. This situation would revert in 1971 as a consequence of a major set of policy changes made in 1970 to be discussed below. Figure 42 illustrates the total realized

Figure 42: SUDAM's Total Investment by Year, Period 1965-1983*.



* Up to September, 1983.

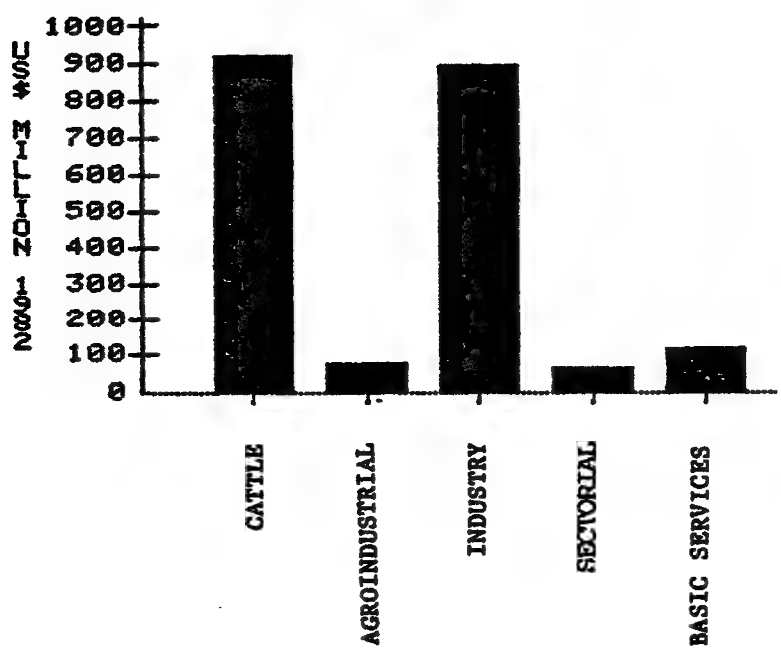
Source: Data Supplied by SUDAM.

investment supported by SUDAM through the fiscal incentives program by year (Mahar, 1979: 95-7; Pompermayer, 1979: 197).

The realized investments (which differ from the resources committed) of SUDAM during these first years reflected the changes brought by Laws 5,173 and 5,174. While in 1965 SPVEA allocated all that year's resources in industrial projects, in 1966 already 15 percent was allocated to cattle raising[18]. The next year, the share of cattle raising projects rose to 40 percent and in 1968 these projects had surpassed industrial project allocations. By 1970, SUDAM allocated more than US$ 81 million in this type of investment while reserving to all industrial projects US$ 58 million. As figure 43 shows, cattle raising and industrial projects have dominated SUDAM's resource allocation. The relative importance of each of those two major types of projects per year is illustrated in figure 44. This trend of resources allocation has continued ever since due to its various impact on the region it will be examined more carefully below. First, an attempt will be made to explain the marked preference given by southern enterpreneurs to investment in cattle raising projects and SUDAM's attitudes toward this trend.

As discussed above, the Belem-Brasilia Highway did not only initiate a new trend toward the immigration of spontaneous settlers from Southern Brazil to Amazonia, but it also attracted large investors in search of land for speculative capital gains. When Operacao Amazonia's fiscal incentives program was unfolded by the Castelo Branco administration, now allowing non-industrial projects to be financed,

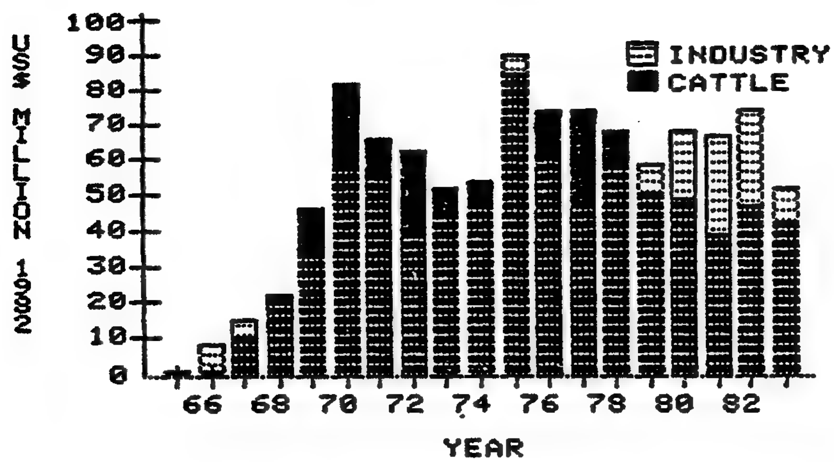
Figure 43 : SUDAM's Total Investment by Sector, Period 1965-1983*.



* Up to September, 1983.

Source: Data Supplied by SUDAM.

Figure 44: SUDAM's Total Investment in Cattle and Industrial Projects, by Year, Period 1965-1983*.



* Up to September, 1983.

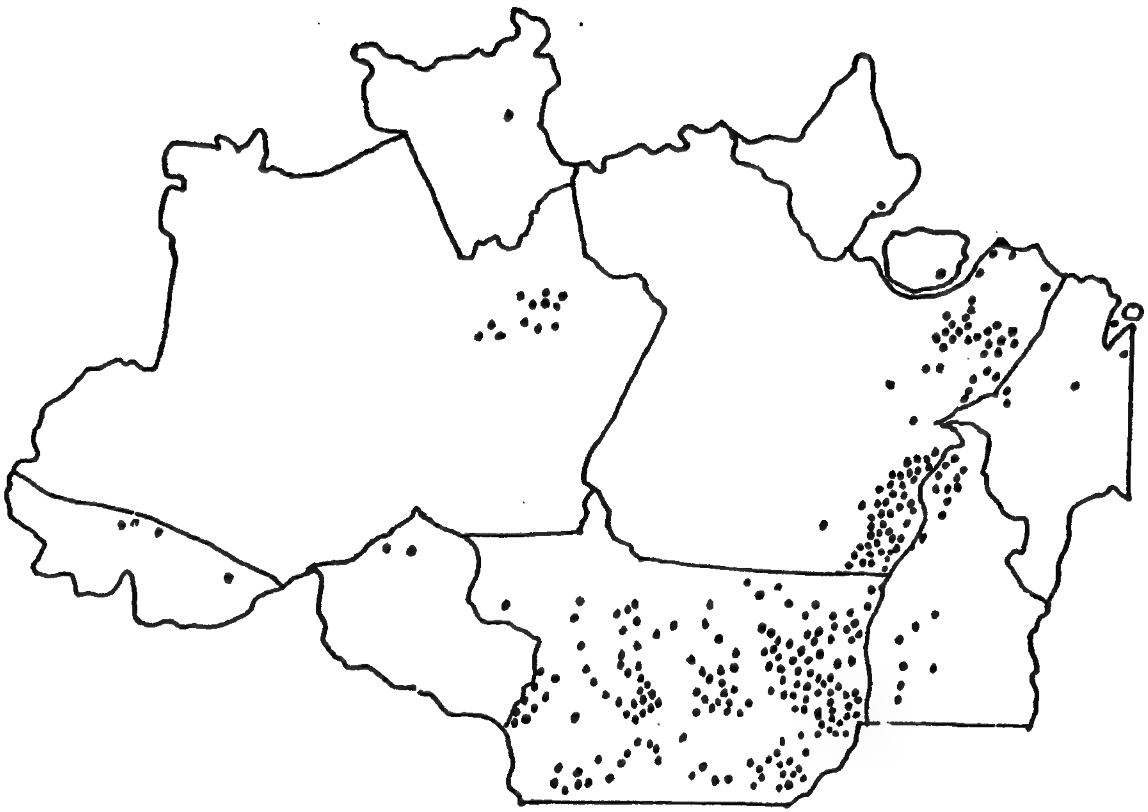
Source: Data Supplied by SUDAM.

Southern capitalists soon perceived the importance of this for their prior experience in the region. They understood that the money they previously used to pay their federal income tax could now be used to buy land in Amazonia, land whose price was increasing substantially due to the road construction program. This money could also be used to finance the cut of the forest, planting of pasture and buying of cattle. In so doing, their ownership of the land would not be contested, since they were complying with the Estatuto da terra requirements of using the land and, at the same token, they were avoiding their land to be "confused" with public land and therefore subject to small posseiro claims.

They soon started presenting SUDAM with cattle raising projects for approval. SUDAM, however, had not anticipated such a tremendous preference for cattle raising projects. As seen above, the PVEA did not contemplate such a pronounced preference by Southern investors. But since SUDAM and BASA were dependent by law on Southerners to prepare the type of projects of their preference, these agencies had to increasingly accommodate to this situation by approving projects in the sectors and locations that these economic groups favored.

The location of cattle projects, as one would expect, has been in the areas of influence of the Belém-Brasília Highway (especially in Southeast and Eastern Pará, Northeastern Mato Grosso and Northern Goiás) and later on new roads built. Figure 45 illustrates the locational distribution of SUDAM supported cattle projects in Amazonia. Other groups argued that SUDAM and BASA should have greater control

Figure 45: Locational Distribution of SUDAM Supported Cattle Projects in Legal Amazonia.



Source: Adapted from Pandolfo, 1982: 10 after SUDAM.

over the type and location of the projects it approved. But this was not accepted by government officials who believed that the enterpreneur should have freedom of choice among the types of projects they wanted to pursue. This is a relevant concern only if capital gains from speculative land exchange were taxed, but they are not.

Associação dos Empresários da Amazônia

To advance the Southern entrepreneur interests in policy making in Amazonia, already by 1968 various members of this group created a special association, the Associação dos Empresários da Amazônia-AEA (Amazon Entrepreneurs Association). This association's members were the more modern and dynamic Brasilian and foreign firms and corporations in the banking, industrial, and agricultural sectors in southern Brazil, most of them located in São Paulo[19]. It was a well organized political lobby, in contrast to other interest groups in the region, and had its headquarters in São Paulo's capital. The objective of this rent seeking interest group "was the defense of the interests of their firms through closer and more direct linkages with government officials ... both in order to pass information to their associates about the best opportunities for investments in the Amazon and to influence state policies in a direction that, from the point of view of the association, would be in the 'interest of the development of the region'" (Pompermayer, 1979: 181).

AEA leaders understood that in the new government organization of the post 1964 revolution, they should act not on legislative

representatives, whose powers had been substantially decreased, but rather, they would have to act directly upon public officials who had been given substantial decision making power (Pompermayer, 1979; Pereira, 1984: 117). AEA promoted meetings on and special tours of the region for those officials, kept close contacts with them, made AEA demands clear, proposed specific lines of actions, and fought opposing interests. Southern investors complained about SUDAM's delays in approving projects, about the extent of Indian reserve lands in Amazonia,[20] and demanded more public investment in roads so as to reduce transportation costs (and increase the price of their land) (Pompermayer, 1979: 180).

AEA has been very aggressive and effective in pursuing its objective. Already in 1969, it was beginning to see the results of its actions. In a speech to the Federation of the Industries of Sao Paulo (FIESP), BASA's president Lamartive Nogueira, stated that

> Ranching ... is an activity that has all the necessary conditions to be transformed into a dynamic sector of the northern economy ... The fiscal incentives and road construction generated a remarkable preference for livestock, and for this reason, a new era in the sector is opened[21].

This type of assertions by officials from BASA, SUDAM and the Ministry of the Interior combined with the growing participation of cattle raising projects in the fiscal incentives and credit programs in Amazonia indicate the impact of the distinctive preference of Southern investors on the decision makers in the public sector (Pompermayer, 1979: 190).

Indeed, cattle projects have generally been given the highest

priority for fiscal incentives funds as also demonstrated by the fact that they have the highest ratio of tax credit to total investment (over 70 percent) approved by SUDAM. This contrasts with industrial and basic service projects for which the importance of tax credit funds was considerably less, accounting for 47 and 30 percent of their total cost, respectively (Mahar, 1979: 99).

It should also be stressed, that the easily obtained and heavily subsidized rural credit program that has been available since the mid 1960s to cattle raisers to cover the other 30 percent of their projects costs has also been an important factor in attracting Southern investors. In fact, these very favorable credit terms, at times given at negative real interest rates, have been for some investors the only source of funds to finance their cattle operations. These favorable rates also give an incentive to those investors to employ borrowed money, rather than using their own funds which could be diverted to other investments (Mahar, 1979: 133; World Bank, 1982: 16-27, 113-5).

If before, the major reason for land speculation in Amazonia resulted from land prices increases due to Belém-Brasília Highway construction, now the heavily subsidized credit and the fiscal incentives program themselves generated an extra demand for land in the region and therefore higher land prices. In the case of rural credit, land itself is a primary determinant of access to the favorable credit. These extra incentives have further increased the rush for Amazonian land (World Bank, 1982: 114; Mahar, 1979: 123-6; Mueller, 1979).

The windfall capital gains of land spectators has been

substantial. Mahar (1979: 126) has found that if an investor bought pasture land in 1966 in northern Mato Grosso and did nothing with it and sold it in 1975, he would realize an untaxed, unearned capital gain of more than 15 percent a year in real terms. Furthermore, these gains have increased with time since if the land were bought in 1970 and sold in 1975, this "investment" would yield more than 43 percent a year in real terms.

Evidence has been collected to support the assertion that cattle raising, as suggestd above, has not been sought by Southern groups as a production entreprise. Cattle has been used as the cheapest way to get control of large land areas (greatest land control/unit of investment) and access to subsidized rural credit. Apparently those enterpreneurs obtain their profit not from cattle production, but rather from land sale and misuse of credit and fiscal incentive funds. Hecht (1982: 80), for instance, has found that, by 1978, 85 percent of early ranches in the Southern Pará area of Paragominas had been sold out. Claudio Dias, then president of AEA, was clear on the source of financial profitability of these transactions:

> ... While the profits from sale of land were substantial, the productivity of the Paragominas area was being maintained only by continuous expansion into forested areas[22].

During the project design phase for SUDAM or credit funds, costs are usually overestimated while in the implementation phase ranch managers underspend. In a field research in 1976, Pompermayer and colleagues found that even the oldest of SUDAM supported projects were behind implementation schedule, not only in terms of the planned size

of the cattle herds which could be as low as 40 percent of the total herd target, but also in terms of projected infrastructure[23]. The surplus capital obtained by these actions could then be transfered back from Amazonia to São Paulo to be invested in other enterprises or used to buy more land in the region (Gross, 1979: 104; Hecht, 1982; Pompermayer, 1979: 155).

These cattle project implementation deficiencies were possible due to the lack of project implementation monitoring by SUDAM. Site inspection of the remote ranching projects has been rare and when they do occur the project managers can stage a part of his project as a show case for SUDAM officials to see. In some cases projects have existed only on paper (Bourne, 1978: 152; Fowaraker, 1981: 157; Hecht, 1982; Lobato, 1978: 57 cited by Pompermayer,1979: 223).

The justifications for the preference of Southern investors for cattle projects can be further understood by the fact that these projects have been found to be financially unprofitable by themselves[24]. As AEA president Claudio Dias indicated, these pastures have low productivity. As estimated by Mahar (1979: 119-122), it can, on the average, vary from 41.5 to as low as 16 kilos of beef per hectare per year. Pasture productivity is relatively good the first few years after the original tropical forest has been cut and burned. This is so due to the liberation of the nutrients retained in the biomass to the soil by the ashes resulting from the burning of extensive forest areas. But this initial productivity decreases after a few years by leaching as happens with the slash and burn agriculture

practiced by Indians and small farmers in the region. Especially phosphorus, potassium, and nitrogen nutrient declines are substantial. Soil compaction and woody weed (secondary forest) invasion of poorly maintained pastures are also reasons for the decline in productivity[25]. Hence, pasture may be a sustained land use only if costly fertilizer and intensive management practices are utilized[26] (Aubert et al., 1972: 19; Engelstad, 1972: 175; Fearnside, 1983: 75; Hecht, 1982: 422; Hecht, 1983).

Since cattle ranchers in Amazonia are not very concerned with the production aspects of their farms, they have a tendency not to apply cautious land management and environmental degradation almost inevitably results. As Claudio Dias, quoted above, indicated, the decreasing productivity observed on old pasture has led to the abandonment of these areas and the cutting and burning of forested areas to form new pasture, a financially cheaper alternative for maintaining a certain production level on their farms[27].

To finance the creation of new pasture land, cattle ranchers in Amazonia also count with SUDAM fiscal incentives and with subsidized rural credit. In fact, since the mid 1970s, reformulations and amplifications, as SUDAM prefers to call these activities, have been increasingly participating in cattle projects supported by SUDAM.

This preference to cut and burn forested areas to form new pasture land has resulted in a type of cattle farming very similar to the slash and burn agriculture practiced by small farmers; i.e., it has resulted in a sort of large scale shifting cultivation. But in the

case of cattle raisers the extension of the deforestation is much larger and the chances for them to clear their lands rapidly is greater[28] (Alvin, 1978: 248; Fearnside, 1983: 75; Hecht, 1982: 262-3, 371, 422; Hecht, 1983; Poelhekke, 1982: 14).

Conversion of tropical moist forest ecosystem into pasture for cattle has been rated, in ecological terms, as the worst of all conceiveable land use alternatives. It causes the waste of flora and fauna resources (with the risk of species losses) and results in a land use of decreasing productivity. This includes the loss of timber which, except for a few very valuable species, are simply cut and burned[29] (Goodland, 1980; Fearnside, 1983; Hecht, 1983; Salati & Vose, 1984: 137).

Cattle raising in parts of Amazonia has been a controversial land use not only for its poor productivity, dubious technical feasibility, and adverse environmental impact, but also for its social impacts. The rush for land control initiated by the Belém-Brasília Highway and aggravated by SUDAM's fiscal incentive program and rural credit policies led to many confrontations among the various land holders in the region. For example, the Pará state land agency pursued a very generous land policy in the early 1960s and sold numerous extensive state <u>terra devoluta</u> tracks without even checking to see whether <u>posseiros</u> or Indians were living on the areas. This type of land exchange, not limited to the state of Pará or to transactions related to terra devolutas, led to tensions and land conflicts between the new land owners by law and the old land holders by fact. As

discussed above, the land posseiros did not have land title or need for it before the arrival of the land speculators.

Land conflicts in Amazonia are also due to the arrival of new landless peasant migrants from other areas of Brazil. Land conflicts in Amazonia have occurred among the four main groups of land holders: large cattle farmers, small posseiros and new peasant migrants, Indians, and land grabbers or grileiros (Davis, 1977; Forawaker, 1981: 37; Hebette & Marin, 1979; Pompermayer, 1979; Santos, 1979).

Another consequence of the presence of cattle raising projects in parts of Amazonia has been a marked concentration of land properties in a few hands, reproducing in the region the skewed land distribution found elsewhere in the country (Hecht, 1982, 1983; Mahar, 1979).

Cattle ranches have also not brought the socio-economic development promised by AEA. Cattle raising has shown few backward and forward linkages (Mahar, 1979: 132-4) and its impact in employment generation has been very reduced. While in the past and in most other areas of Amazonia labor scarcity has been a historic concern, in those areas under the influence of the Belém-Brasília Highway, the displaced posseiros and new migrants have found little job offers by cattle raisers.

Job offers by these farms are concentrated in the first years of the enterprise during the implementation phase when forests are being cut, roads built, and the pastures formed. After this phase, permanent employment is considerably lowered. It has been estimated that, even considering the temporary employment created during the

implementation phase, these jobs are very expensive amounting to an average of US$ 63,000 of investment per job created[30]. The number of jobs created per unit of land area is also very low. The land to labor ratio has been estimated to be around 500 ha: 1 for all property land or around 300 ha: 1 job if only pasture land is considered. As Mahar (1979) has stressed, there is a chance that these numbers, calculated on the basis of project information, may in fact be overestimated.

In addition, some authors have indicated that these few employed rural workers in many cases are ruthlessly exploited by the cattle raisers and their field supervisors (Cardoso & Muller, 1977: 178-87; Mueller, 1980: 152).

Despite all these controversial aspects of cattle farming in terra firme areas of Amazonia, this activity continues to be strongly supported by the federal government; perhaps, a consequence of the effective work done by AEA.

SUDAM also invested in other sectors of which the industrial, as mentioned above, is the most important. Unlike agricultural projects which for SUDAM means essentially cattle raising projects, industrial projects mean several types of industries including forest-based industries. Table 8 summarizes the SUDAM-approved industrial total investment by subsector through mid-1976. A total of 178 projects were approved in the period of which two-thirds were new industries. In decreasing importance the mining, food, forest-based, chemicals, and non-metalic mineral subsectors accounted for almost 70 percent of the

Table 8 : SUDAN-Approved Total Industrial Investment by Subsector Through Mid-1976. (In US$ million dollars of 1982.)

Subsectors	Total		New		M/E	
	$	Number	$	Number	$	Number
TOTAL	1,995.7	178	1,370.8	118	625.1	60
Mining	305.2	7	269.7	7	37.0	2
Manufacturing	1,689.1	170	1,100.0	112	588.1	58
Food	413.7	37	240.7	26	173.2	11
Forest-Based	295.7	31	206.4	21	89.3	10
Wood Products	258.0	23	191.6	17	66.4	6
Rubber	33.3	5	13.5	2	19.8	3
Paper	3.4	2	0.3	1	3.1	1
Furniture	1.0	1	1.0	1	..	..
Chemicals	208.1	28	162.5	17	45.6	11
Nonmetallic minerals	138.5	7	103.4	5	35.0	2
Textiles	121.6	15	73.2	10	48.4	5
Metallurgy	109.0	8	99.3	6	9.8	2
Electronics	104.8	9	87.4	7	17.4	2
Transport equip.	78.8	5	10.0	2	68.9	3
Beverages	65.7	8	41.4	5	24.3	3
Apparel	22.5	3	12.6	1	9.9	2
Leather	16.8	3	12.4	2	4.4	1
Pharmaceuticals	14.2	1	14.2	1	..	..
Perfumery	14.1	3	9.1	2	5.0	1
Tobacco	.5	1	.5	1	..	..
Miscellaneous	68.4	8	21.2	4	47.2	4

Numbers may not add due to rounding. M/E - Modernization/Expansion.

Source: Adapted and calculated from Mahar(1979: 107) after IPEA/SUDAN/NAEA (unpublished survey).

total investment. Forest-based industries were dominated by those processing wood products such as saw timber, plywood, and veneer.

Zona Franca de Manaus

During the first years after the creation of SUDAM and the new fiscal incentive policies, it became clear to policy makers that the state of Pará, due to its greater infrastructure and proximity to Southern consumption centers, was being preferred by Southern investors for fiscal incentive project implementation. During the period 1964-66, less than 5 percent of the total investments approved by SUDAM was located in western Amazonia. The Castelo Branco administration then decided to alter a free trade zone that had existed in Manaus since 1957 so as to transform the city in a development pole to spread development to western Amazonia. Decree-Law 288 of February 28, 1967 regulated by Decree 61,224 of August 28, 1968 defined the Zona Franca de Manaus-ZFM as "an area of free commerce of import and export and of special fiscal incentives, established to create in the interior of Amazonia, an industrial, commercial, and agricultural center..." (art. 1). ZFM was located in a 1,000,000 ha area including the city of Manaus. In the ZFM, foreign goods, with few exceptions, imported for local consumption or to be used in industrial, agricultural, or fishery production processes are exempted from import tax and manufacturers sales tax (Imposto sobre Produtos Industrializados-IPI). The export of goods from the ZFM regardless of their origin is also exempt from export tax. However, when products utilizing imported imputs are sold

in other parts of Brazil, the manufacturers have to pay the import tax reduced in proportion to the value added within the free trade zone. Imported consumption goods can also be sold to Brazilian tourists free of import duty up to a pre-fixed amount of US dollars (f.o.b.) per person.

Projects to take advantage of the ZFM benefits would have to be submitted for approval to a new organization created to administer the free trade zone: Superintendência da Zona Franca de Manaus-SUFRAMA. This new superintendencia, like SUDAM, was also under the supervision of the Ministry of the Interior.

A year after the creation of the ZFM, Decree-Law no. 356 of August 15, 1968 regulated by Decree no. 63,871 of December 20, 1968 expanded part of the benefits of the free trade zone to other parts of Ocidental Amazonia. Through entrepots to be established in the cities of Rio Branco (Acre), Boa Vista (Roraima), and Porto Velho (Rondonia), a selected group of foreign goods--including machineries and equipment for agriculture and industrial production--to be consumed or utilized in the region--were exempted from tariffs and IPI when approved by SUFRAMA. Brazilian goods imported through these entrepots and approved by SUFRAMA were exempted from IPI and the Imposto de Circulação de Mercadorias-ICM. Later in 1975, Decree-Law 1,435 of December 15 exempted any firm located in legally defined Ocidental Amazonia (states of Amazonas and Acre and federal territories of Rondonia and Roraima) and processing regional agricultural products (except cattle) from IPI when approved by SUFRAMA[31].

Analyses of the ZFM program have been very few not only in number, but also in the types of variables studied. Mahar (1978: 140-163) using data up to 1976, has studied the effects of these policies in terms of their effects on commerce, industrialization, and on the city of Manaus. He found that Manaus was transformed from a generally trade surplus area before the changes of the ZFM to a position of trade deficit. This resulted from the substantial increase in imports from foreign nations as well as from other parts of Brazil and a more modest growth in sales to other parts of Brazil and a virtual stagnation in exports to other countries. Foreign imports grew at an average annual rate of 46 percent in the period 1967-75 in real terms to Cr$ 2.3 billion while domestic imports grew at a rate of 31.1 percent to Cr$ 2.6 billion in the same period. Exports to the domestic market also grew but at a slower rate of 27 percent to a total Cr$ 2.6 billion in 1975 whereas exports to foreign markets grew at only slightly more than 3 percent a year to a total of only Cr$ 88.7 million in 1975.

It is interesting to notice that, on the one hand, the export to foreign nation from Manaus continued to be dominated by the forest-based sector as tables 9 and 10 show. On the other hand, foreign imports after 1967 concentrated on mechanical equipment and consumer goods--which were resold in the duty free zone to tourists and local residents.

In 1975, the ZFM foreign trade deficit amounted to 45 percent of the Brazilian trade deficit excluding imports of petroleum and

Table 9 : Manaus Free-Trade Zone: Structure of Foreign Trade, 1958 and 1975.
(In Millions of US Dollars at Current Prices.)

Product Category	Exports (f.o.b.) 1958* $	%	1975 $	%	Imports (c.i.f.) 1958* $	%	1975 $	%
TOTAL	6.21	100.0	24.86	100.0	6.65	100.0	247.75	100.0
Vegetable Products	4.58	73.8	9.01	36.2	-	-	1.72	0.7
Rubber, plastics	0.62	10.0	2.01	8.1	-	-	5.71	2.3
Wood and Wood Products	-	-	1.78	7.2	-	-	0.97	0.4
Textiles, Clothing	0.07	1.1	3.11	12.5	-	-	22.15	8.9
Chemical Products	0.25	4.0	5.22	21.0	0.03	0.5	5.56	2.2
Transport Equipment	-	-	0.56	2.3	0.20	3.0	8.22	3.3
Basic Metals	-	-	0.01	0.0	0.04	0.6	15.45	6.2
Electrical Equipment	-	-	0.10	0.4	-	-	70.07	28.3
Mechanical Equipment	-	-	0.14	0.6	0.15	2.3	38.25	15.4
Audio and Optical Equipment, Watches	-	-	0.31	1.3	-	-	35.30	14.3
Precious Stones and Metals, Jewelry	-	-	0.20	0.8	-	-	17.81	7.2
Other	0.32	5.2	1.30	5.2	0.08	1.2	22.34	9.0

Note: - Dashes indicate zero or no imports in category. * Port of Manaus.

Source: Adapted from Mahar, 1978: 146.

TableD: Export Structure of the State of Amazonas in 1967.
(In Current Prices.)

Product Category	Cr$1,000,000	Percentage
Fruits and Nuts (Brazil Nut)	7,745	25.5
Sorva, Balata, Ucuquirana	6,594	21.8
Wild Animal Skins	6.408	20.8
Chemicals & Rosewood Oil	3,367	10.9
Jute, Textile	2,971	9.7
Other Skins	1,436	4.3
Wood and Wood Products	942	3.0
Others	1,252	4.0

Source: Modified from Lima, 1971: 48.

wheat. This was the second year of the first oil price shock and the government of General Ernesto Geisel decided to restrict imports in the ZFM. Decree-Law no. 1,455 of April 7, 1976. Besides restricting the amount of dollars that could be spent on the duty free shopping of Manaus by turists, this legislation also established an annual ceiling on total ZFM foreign imports and SUFRAMA was put in charge of allocating import quotes. SUFRAMA has shown preference in its quota allocation process to imports going to industries in detriment to those going to commerce. This preference resulted in the reduction of commerce's participation in the total import value from 45 percent before the restrictions to 24 percent.

Another consequence of the ZFM program was the attraction to Manaus of industries which were being installed mostly in Parå or other parts of the country before that policy change. Table II illustrates the types of industries that have been approved by SUFRAMA to take advantage of ZFM fiscal subsidies. It should be noticed that forest-based industries have been supported by SUFRAMA although as a policy, the superintendency has more recently been increasing its support to the electric-electronics, watches, and transportation (motocycles) industries. Unlike forest-based industries, these are industrial activities with no non-fiscal advantages to be located in Amazonia. These industries were created essencially as assembly lines to put together imported components from abroad and South Brazil. In more recent years, SUFRAMA has tried to reduce the importation of parts by favoring the approval of new projects whicn produce these

Table 11: Industrial Projects Approved by SUFRAMA, 1968-1975 and 1968-1982. (Values of December 1982.)

Industry Types	1968-1975*					1968-1982**				
	Number of	Investment		Employment		Number of	Investment		Employment	
	Projects	US$ million	Percent	Number	Percent	Projects	US$ million	Percent	Number	Percent
Electric- Electronics	25	144.2	19.8	6,861	26.2	44	94.2	14.9	21,860	40.8
Forest-Based	22	84.7	11.7	3,998	15.2	42	92.4	14.6	6,192	11.6
Wood Products	19	81.9	11.3	3,747	14.3	30	83.7	13.2	5,332	10.0
Furniture	1	0.7	0.1	90	0.3	8	6.5	1.0	658	1.2
Paper	2	2.1	0.3	161	0.6	2	1.0	0.2	92	0.2
Rubber	..	..	..	..	..	2	1.2	0.2	110	0.2
Transport Equipment	11	43.4	6.0	1,473	5.6	12	90.3	14.2	4,595	8.6
Metallurgy	10	59.1	8.1	1,737	6.6	19	59.5	9.4	1,353	2.5
Non-metallic Minerals	2	3.2	0.4	161	0.6	7	58.0	9.2	1,297	2.4
Beverages	5	11.4	1.6	468	1.8	8	52.9	8.3	2,526	4.7
Watches	included in miscellaneous					12	37.1	5.9	2,183	4.1
Textiles	5	158.5	21.8	3,903	14.9	8	34.6	5.5	3,214	6.0
Plastics	3	5.8	0.8	280	1.1	13	29.2	4.6	3,258	6.1
Food	8	16.1	2.2	1,109	4.2	15	23.2	3.7	1,200	2.2
Machinery	2	4.0	0.6	168	0.6	9	11.8	1.9	761	1.4
Chemicals	9	55.9	7.7	1,058	4.1	10	8.2	1.3	563	1.1
Optical Equip.	included in miscellaneous					7	6.9	1.1	914	1.7
Apparel	4	1[illegible].3	1.4	696	2.7	4	1.4	0.2	382	0.7
Miscellaneous	34+	133.7	18.4	4,292	16.4	22++	34.5	4.1	2,855	5.3
TOTAL	140	728.2	100.0	26,154	100.0	235	634.1	100.0	53,534	100.0

Notes: . Excludes projects whose incentives were suspended or cancelled.
. Numbers may not add due to rounding.

+ Includes product lines such as jewelry, toys, watches, optical equipment glassware, leather, perfumery, and printing and publishing.

++ Includes product lines such as jewelry, toys, glassware, leather, perfumery, and printing and publishing.

Sources:
* Calculated from Mahar (1979: 155) based on unpublished data provided by SUFRAMA.
** Calculated from SUFRAMA (1983a: 15).

intermediate goods (Eficaz, 1983: 1-4).

Most of the industries supported by SUFRAMA have located their installations in Manaus. Of the 2,235 enterprises implanted in Ocidental Amazonia with the support of SUFRAMA up to December of 1982, only 15 were located outside of Manaus. Of those, 10 were forest-based industries. *Table 12* provides more details on the forest-based sector industrial projects approved by SUFRAMA from 1968 to 1982. Investments on lumber, plywood, and veneer have dominated those industries[32].

The increased commercial and industrial concentration in the city of Manaus as a consequence of the ZFM program subsidies has limited its impact on the rest of Ocidental Amazonia. In fact, the available data suggests that instead of a pole for the dispersion of economic development in the region, Manaus has become an attraction pole, and the ZFM policies instead of promoting regional development have indeed become urban development policies.

The increased employment opportunities and income brought to Manaus by the program have become attraction factors to rural inhabitants to move to the Amazonas state's capital. Manaus population, which had grown in the 1950s at an average annual growth rate of 2.2 percent jumped to 6 percent in the 1960s and to 7.4 percent in the 1970s to reach over 634,000 inhabitants, c.a. 44 percent of the states total population. The average annual growth rate of Amazonas' rural population grew at a much slower and decreasing rate of 2.4, 1.5, and 0.4 percent, respectively, while the state's population as a whole grew at 3.3 in the 1950s, 3.0 in the 1960s, and 4.1 percent in the

Table 12: Forest-Based Sector Industrial Projects Approved by SUFRAMA from 1968 to 1982.

Industry	Number of Projects	Investment US$1,000‡	Employment	Location‡‡
Wood Products	42	90,212	5,850	
Lumber	16	50,016	1,124	H, (9)M, Mn, I, Ca, Co
Veneer	2	1,017	305	I
Plywood	2	5,318	1,401	M
Plywood & Veneer	3	12,110	1,373	(2)M, I
Lumber/plywood/ Veneer	3	12,460	725	M
Joinery & Crate	4	2,802	342	M
Furniture+	8	5,591	469	M
Miscelaneous++	4	897	111	(3)M, B
Non-wood Products	6	17,261	623	M
Paper	2	1,020	92	M
Nuts, Oils, Fiber	2	15,081	421	M
Rubber	2	1,161	110	H, Mn
TOTAL	48	107,473	6,473	

Numbers may not add due to rounding.

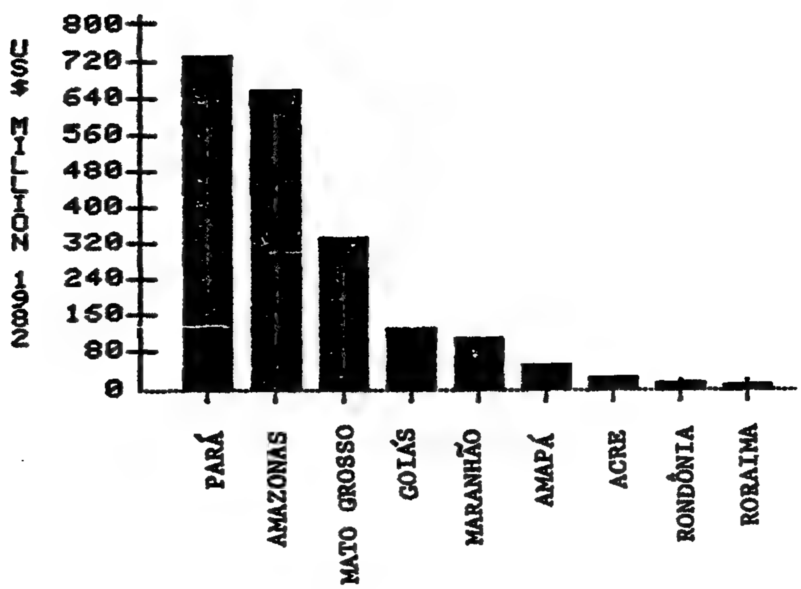
‡ Values of December of 1982.
‡‡ B: Borba; Ca: Carauari; Co: Coari; H: Humaita; I: Itacoatiara; M: Manaus; Mn: Manacapuru.
\+ Includes cabinetes for electronic goods.
++ Includes industries producing boats, pre-fabricated houses, and sporting goods.

Source: calculated from SUFRAMA, 1983a (based on projects' descriptions).

1970s. These concentrations of economic and social activities resulting from the ZFM program has characterized what Mahar has named the enclave nature of this type of development. SUDAM's investment in the state of Amazonas (mostly in the ZFM) and in Pará have comprised the major share of resource allocation in Amazonia by this agency, as shown in figure 46 .

An interesting concept utilized by SUFRAMA in the ZFM region is that of an Agricultural District. As defined in article 1 of Decree-Law 288, the ZFM should also include the agricultural sector. But it would be only after 1976 that SUFRAMA started to actively promote this concept. SUFRAMA's Agricultural District is an area of 589,334 ha located 30 km north of the city of Manaus but within the 1,000,000 ha ZFM area. It was created basically as a model for the occupation of the terra firme of Ocidental Amazonia as well as to increase the supply of food to the Manaus market, and to produce exportable goods. The area is typical of that part of Amazonia with vegetation dominated by the tropical forest and by the non fertil but physically good Oxisols. Of the total area, SUFRAMA has estimated that only 40 percent of the District's land (236,000 ha) offer reasonable conditions for some type of agricultural activity. Initially in 1976, land tracks varying from 100 to 15,000 ha were sold by SUFRAMA for a symbolic price. Later the upper limit was reduced to 3,000 ha and in 1982 it was further reduced to 1,000 ha. But the experience so far has had limited impact in the agricultural supply of the city of Manaus since only 40 percent of the 80,029 ha sold by 1983 have actually been

Figure 46: SUDAM's Total Investment by State, Period 1965-1983*.



*Up to September, 1983.

Source: Data Supplied by SUDAM.

planted (SUFRAMA, 1983b).

In sum, the Zona Franca de Manaus program introduced by the Castelo Branco administration as part of Operação Amazônia has had limited impact on Ocidental Amazonia although Manaus itself has substantially benefited from it.

The 1965 Forest Code

As part of Castelo Branco's changes in the basic legislation of the country, one should be mentioned for its importance for the forest-based sector. On September 15, 1965 Castelo Branco signed the New Forest Code for the country in substitution to the 1934 Forest Code. This law (no. 4,771) starts by introducing the concept that property rights over forested lands should be limited since these forests, due to the services they provide to the lands they cover, are of interests to all members of the Brazilian society. These limitations were then described. Article Two establishes as permanent preservation areas those located close to water bodies (rivers, streams, and lakes); in areas of more than 45 degree[33] slope and top of hills and mountains, and others. Other land areas could be declared as permanent preservation areas by public authorities for various specific reasons including erosion control, and fauna and flora protection. In this category of permanent preserved forest were also included the Indians lands[34].

The new forest code also granted the public sector the right to create national, state, and municipal parks and biological reserves as

well as national, state, and municipal forests (art. 5). However, it did not even mention the concept of Forest Reserves which existed under the 1934 Forest Code and which had resulted in the creation of almost 17 million ha of land under this category by the public sector. In practice, the Forest Reserves already created have been almost completely ignored by the public sector.

Out of the 48 articles of this law only 2 directly mention the Amazon Region. Article 15 prohibited the wasteful exploitation of the native forests of the region. These forests could only be exploited under the prescriptions of technical conditions of management to be established by the public sector within a year from the publication of the law. The second article dealing with Amazonia directly was article 44 which established that, while the public sector prepared the management perscriptions, clear cut of Amazonian forests would be allowable only in 50 percent of each land property. It took almost two decades before IBDF made a small attempt at defining some of the technical conditions for the Amazonian tropical forest management. During this period, articles 15 and 44 had become in fact the basic Brazilian forest policy for the region.

On July 3, 1984, however, IBDF approved Normative Directive (Portaria Normativa) no. 302-P which, for the first time, provided an initial attempt at regulating forest management in Amazonia. Although not referring to the region by name, this directive established norms for the conversion of Amazonian tropical forest. IBDF decided that for it to give authorization to convert the forest into agricultural land

uses, applicants would have to prove the land use capacity of the soil of their property to the proposed agricultural production. If the soil is capable of the type of production envisioned, IBDF would approve conversion of only (1) 50 percent of the land property when the forest has low wood production potential, or (2) 20 percent of the land property when the forest is rich in wood resources. The other 50 or 80 percent of the land property left under forest cover would constitute forest reserves.

In the case of agricultural colonization projects, IBDF now requires that forest reserves be previously defined and possibly be in one single block. These forest reserves can only be used under the prescriptions of an IBDF-approved Exploitation and Forest Management Plan. The Forest Management Plan is required by IBDF to be "rational", based on a sustained yield regime, and should be designed to maximize raw material production. This last requirement is particularly inappropriate. Since raw material production involves economic decisions, the management plan should be designed to maximize profits over time or the net present value of the operation and not output.

Directive 302-P is an extensive document which, despite some easily identifiable problems, has only briefly addressed the Amazon forest management issue. However, before this directive any type of forest management in Amazonia was legally forbidden, leaving land owners only the option of conversion of 50 percent of the tropical forest of their property to other land uses. If these norms are properly enforced, now any conversion of tropical forest in Amazonia

will be possible only in those areas where soils are appropriate. But even when this is the case, the deforestation will depend on the wood potential of the forest. The forest not approved for conversion, forest reserves, can only be used under management plans approved by IBDF.

Various problems for the successful implementation of these norms could be listed here, but it should be stressed that this is the first, though small, attempt that IBDF has formally made to address the issue of a forest policy for Amazonia. A more complete analysis of these norms are, however, necessary but too specific for the general scope of this study.

Other Legislations

A complementary law to the Forest Code was passed a little over a year later on January 3, 1967: the Law of Fauna Protection. Law no. 5,197 established that all wildlife is property of the state and prohibited wildlife utilization, destruction, hunt, persecution or capture. Small scale non-professional hunting is only allowed under special legislation. Wildlife products such as skins were prohibited of being marketed inside of the country or exported unless produced in legalized creation centers. Smith (1976a; 1978; 1979) discuss the limited effect of the Law of Fauna Protection in Amazonia.

To enforce these laws, President Castelo Branco created the Instituto Brasileiro de Desenvolvimento Florestal-IBDF (Brazilian Institute for forestry Development) under the supervision of the

Ministry of Agriculture through Decree-Law no. 289,[35] of February 28, 1967. IBDF's main task would be to formulate the forestry policy for the nation as well as to coordinate, implement, or assure implementation of necessary measures to achieve (1) the rational utilization, protection, and conservation of renewable natural resources; and (2) the development of the forest-based sector, in accordance with the existing laws. Besides the Forest Code and the Fauna Protection Law, IBDF was also encharged with the implementation of the fiscal incentive program for reforestation created by Law no. 5,106 of September 2, 1966. The implementation of the fiscal incentives program for reforestation, in fact, has been considered as the basic reason for IBDF's creation and indeed it has dominated the activities of the organization ever since. The new organization resulted from the combination of the Instituto Nacional do Pinho (National Institute for Pine), the Renewable Natural Resources Department of the Ministry of Agriculture and, later, the Instituto Nacional do Mate (National Institute for Mate).

Castelo Branco signed several other laws which affected the Amazon region such as the new Mining Code (Decree-Law 227 of February 28, 1967), Fishery Code, and Law no. 5371 of December 5, 1967 which created the Fundacao Nacional do Índio-FUNAI (National Foundation for the Indian) in place of the Serviço de Proteção ao Índio-SPI (Indian Protection Service). He also approved a new Constitution on January 24, 1967 which further centralized the powers of government in the hands of the chief executive, a trend initiated by Vargas.

These institutional changes promoted by the first administration of 1964 revolution set the pace for a new phase in Brazilian development and had a substantional impact on Amazonia. Of those, the Estatuto da Terra and the laws of Operação Amazônia have had the major impact.

V.2 Small-Settlers Agricultural Colonization: The Transamazonica Highway Scheme.

As he had promised, President Castelo Branco steped down from government on March 15, 1967 when his successor, Marchal Arthur da Costa e Silva took office for a four-year term[1]. Costa e Silva faced several political and social unrests which culminated with the promulgation of Fifth Institutional Act. This act disbanded congress, suspended the constitution, gave more authoritative powers to the president, closed down state legislatures, imposed censorship, and included other measures. But it was during his administration also that the so called Brazilian economic miracle, with annual average economic growth rates varying from 8.3-14 percent with reduction in inflation and unemployment during the period 1968-1974, began (Burns, 1980: 516-20; Baer, 1983).

The second president of the 1964 revolution, however, would not complete his term in office because he suffered a cerebral hemorrhage in late August, 1969, which left him partially paralyzed and unable to speak. The civilian vice-president, Pedro Aleixo, who, by the constitution, should substitute the president was not allowed to do so by a junta of the three military ministers (Air force, Army, and Navy) which took over power. A little over a month later, the junta had chosen a new predident, General Emilio Garrastazu Médici, who was inaugurated on October 30, 1969. On the same day, a new constitution was promulgated which is still the basis for the political organization

of Brazil nowadays.

Unlike Costa e Silva, who did not bring major changes in policies for the Amazonian region, the Médici administration would introduce major changes towards the region. Most of those changes were made to support the implementation of a new program of road building in the region and its associated small settlers agricultural colonization scheme. Of those roads, the Transamazonica highyway was the most important. This program represented a major shift in the basic strategy adopted by the federal government towards the region. The Transamazonica road building program and associated agriculture colonization have been the most extensively studied and criticized part of Amazonia development history[2]. Operação Amazônia did continue during the Médici administration but with a lower priority, as discussed below.

Reasons for the Scheme

Several reasons have been mentioned by students of the region as causes for the design of this new approach[3]. Doubtlessly, the traditional Brazilian geopolitical concern in Amazonia was among those reasons (Cardoso & Muller, 1977: 167-78; Smith, 1982: 12-4; Tambs, 1974). The years which preceded Operação Amazônia saw the publication of two influencial books about Amazonia and its geopolitical importance for the country which brought a renewed emphasis on the topic. The first one was written by Army officers Golbery do Couto e Silva[4] in 1957 with the title "Aspectos Geopolíticos do Brasil." The second book

by historian, governor of the state of Amazonas, and first head of SPVEA Arthur Cesar Ferreira Reis, was very emphatic about the national sovereignty issues of the region, as its title, "Amazônia e a Cobiça International" (Amazonia and the International Covetousness) indicates.

The geopolitical concerns discussed by these authors were further aroused by a series of events that occurred in the 1960s. In 1965, the U.S. National Academy of Sciences developed a plan for the U.S. Agency for International Development-USAID, which envisioned the creation of a tropical research foundation in Latin America with headquarters in Belém or Manaus. There, foreign scientists would investigate the food production possibilities of the Amazon Valley. Although this plan recommended cooperation with South American Universities, the proposal, either for insensivity or ignorance of the IIHA legacy, overlooked the necessity for cooperation with such Brazilian institutions as INPA implying that the foundation would operate beyond control. Thus, this episode revived old fears of internationalization of the region. Under the leadership of Arthur C. F. Reis, Brazilians quickly terminated the proposal (Galey, 1977: 187).

Another and much more publicized North American proposal came in 1967 from the Hudson Institute in New York, a "think tank" that at times worked in projects for the Pentagon. The proposal, made by Herman Kahn and Robert Pamero, suggested the contruction of an earth dam across the lower Amazon River for the production of electricity. This dam would create a 24 million ha lake from Santarem to Tefé which would submerge most riverside cities including Manaus. Although the

proposal found some defenders in Brazil, it was severely criticized in ecological terms. But the fact that it was also seen as representing an attempt to "internationalize" the region resulted in its political infeasibility (Galey, 1977: 187-900; Meggers, 1971: 154; Mendes, 1971: 33-75).

At the same time that Kahn's "Great Lake" proposal was being discussed, a national scandal erupted over large North American land purchases in Amazonia, which resulted in the installation of a Enquiry Commission in Congress (Galey, 1977: 187-90; Ianni, 1979a: 99-127).

Also contributing to increase the geopolitical concerns of Brazilian officials was the fact that Brazil's most important neighbors in Amazonia had already started programs of road building and integration of their portions of the region such as _Carretera Central_ (Transandean Route) and its associated _Marcha para la Selva_ (March to the forest) program by Pery; Bolivia's _Carretera Marginal de la Selva_ (The Frontier Forest Highway); and other road building programs by Venezuela and Equador. This fact certainly contributed to President Médici's decision to create in Brazil the campaign _Integrar para Não Entregrar_ (integrate so as not to surrender) designed to obtain public support for his program for Amazonia (Tambs, 1974).

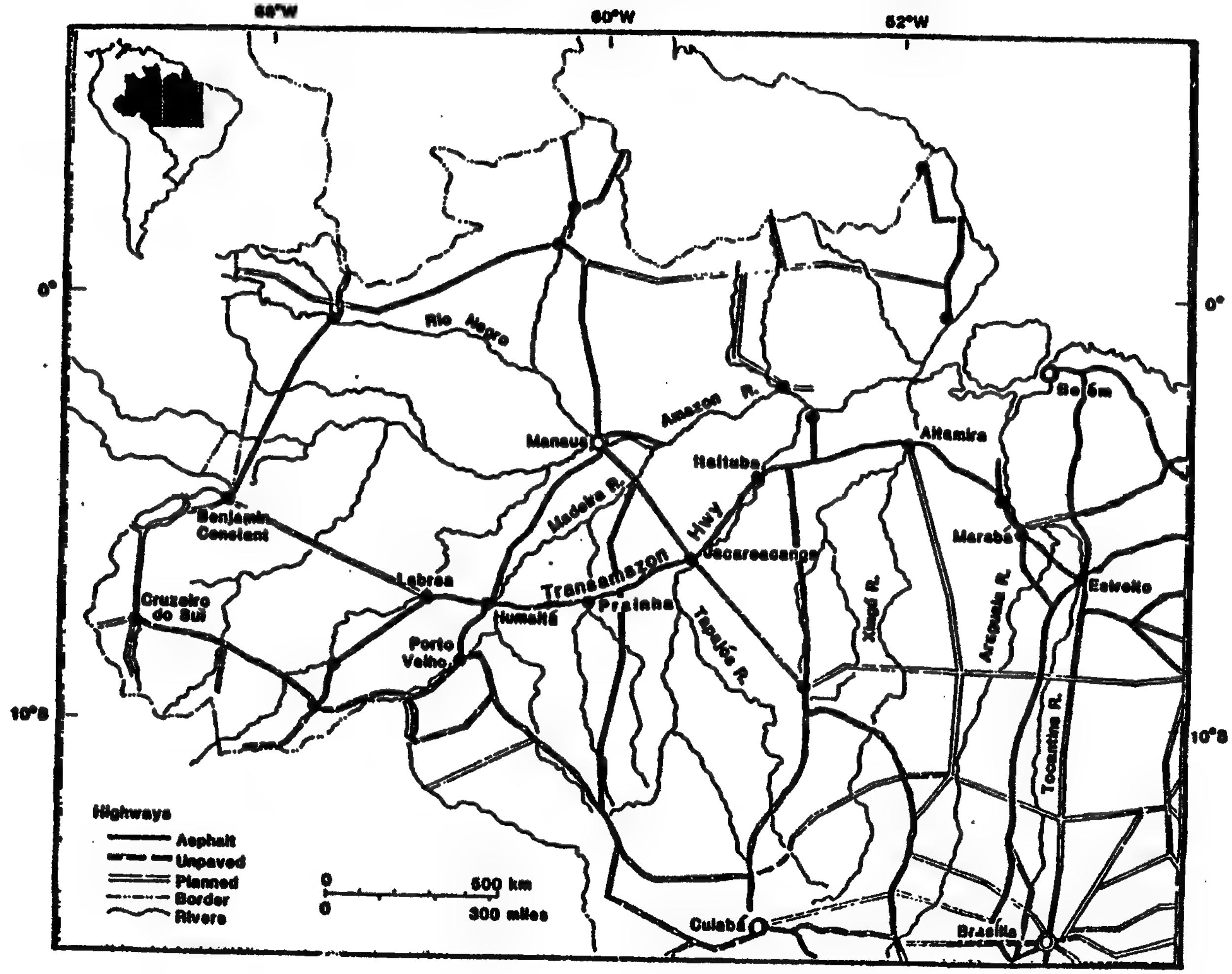
This type of campaign combined with the use of political symbols such as "Brazil Emergent Potency", especially at a time when the country had just won the World Soccer Cup and the Brazilian economic miracle was in full force, have been seen by some observers as

suggesting that the Transamazonica Program was used as another political symbol to promote the revolution and the Médici administration[5] (Ianni, 1979b: 53; Moran, 1983: 297-8).

Access to natural resources was also among the reasons to justify the construction of a road network in the region (Cardoso & Muller, 1977: 167-78; Moran, 1983).

But the reason which more directly contributed to Médici's decision was the strong drought that was occurring in the Northeast region at that time. In fact, Médici confirmed in an interview, years later in 1984, that the utmost reason for his decision to approve the construction of the Transamazonica highway was what he saw in his visit to the Northeast which left strong impressions on him (Scartzini, 1984: 16). The basic concept underlining the program was to build an east-west road that connected the Northeast with Amazonia so that migration from that region could be facilitated and thereby reducing the problems of the region, including land distribution problems[6]. Figure 47 shows the Brazilian Highway network in Amazonia as it came to evolve years later, including the Transamazonica (Transamazon) Highway. This concept drew from the historical tradition of Northeasterners to move to Amazonia in times of droughts as occurred during the rubber boom period but which had diminished when the economic growth observed in South Brazil made that area a more attractive region for their migration[7]. The road and colonization programs of the Médici Administration had also the extra advantage of reorienting the northeast migrants away from the increasingly crowded metropolitan centers of the

Figure 47 : The Brazilian Highway Network in Amazonia.



Source: Smith, 1981: 756.

South[8]. (Arruda, 1976: 24-5).

The New Institutional Arrangement

To implement the new policy for Amazonia, President Médici signed a series of new laws. The first one, signed just a few days after his return from the visit to the Northeast, was Decree-Law no. 1106 of June 16, 1970 which created the Programa de Integração Nacional-PIN (National Integration Program). The major objective of this program was to promote a greater economic integration of Amazonia with the rest of the country and especially with the Northeast. The program was allocated c.a. US$ 1,050 million for the fiscal years 1971-1974, most of which was to be used in the construction of Transamazonica (2,475 km) and Cuiaba-Santarém (1,500 km) highways as well as for the associated agricultural colonization and agrarian reform program on a strip of 10 km on each side of those roads[9].

President Médici decided that these funds would be obtained from the income tax deductions to be applied on all existing fiscal incentive programs, including SUDAM's and SUDENE's. PIN was financed by a reallocation of those funds in the amount of 30 percent of the fiscal incentives programs deductions[10].

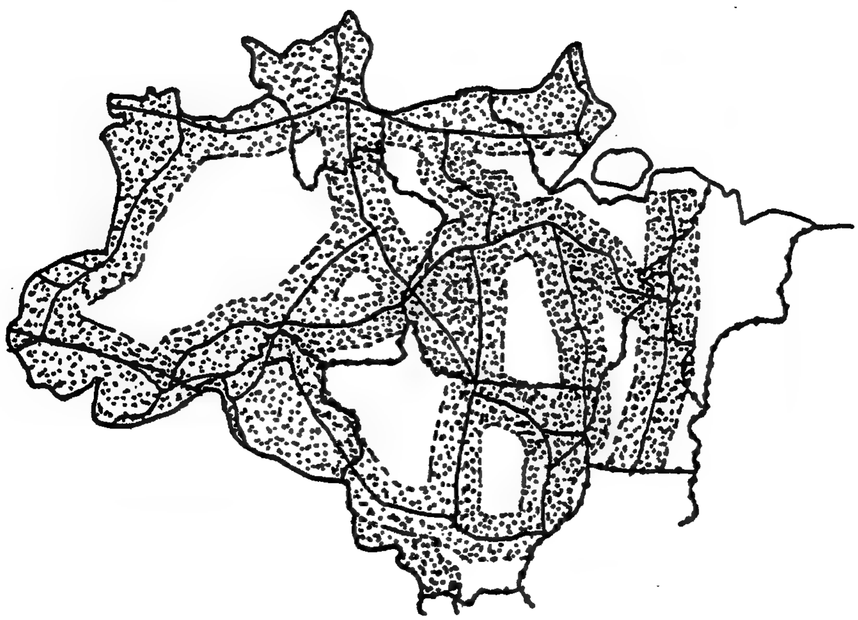
To implement the agricultural colonization part of PIN, President Medici decided to create a new federal organization in place of Castelo Branco's INDA and IBRA[11]. The Instituto Nacional de Colonização e Reforma Agrária-INCRA (National Institute for Colonization and Agrarian Reform) was now the organization responsible

for all the tasks previously divided between INDA and IBRA. That is, it is responsible for agrarian reform, the execution of official colonization, and the promotion of private colonization, as well as rural development.

On April 1, 1971 President Médici approved Decree-Law no. 1,165 which represented a major change in the way terras devolutas in Amazonia were administered and substantially increased INCRA's influence in the region. This legislation declared as indispensible to the national security and development all the terras devolutas situated in a 100 km strip on each side of federal highways already constructed, being constructed or simply planned in Amazonia Legal. By declaring those lands as indispensible to the national security and development, Médici transferred them from the Amazonian states' control to the control of the federal government[12]. This implied that the federal government, through INCRA, would control about 215 million ha of lands in Amazonia. Subsequent legislation by Médici a few months before the end of his term further expanded the federal lands in the region. Combining the land areas on the 150 km national security strip along the Brazilian international frontiers already under federal government control with the lands in the 200 km strip along the federal highway resulted in INCRA's control over the great majority of terras devolutas in Legal Amazonia, as illustrated in figure 48[13].

On July 6, 1971 President Médici completed the basic legislation framework of his new approach to Amazonian development by signing Decree-Law 1,179 which created the <u>Programa de Redistribuição de</u>

Figure 48: Areas Under INCRA's Jurisdiction in Legal Amazonia.



State, Territory, and Legal Amazonia Boundaries.

Federal Roads Planned, in Construction, or Constructed.

Area of Decree-Law no. 1164/71 and Frontier Strip.

Source: Adapted from Yokota, 1981: 30.

Terras e de Estímulo a Agroindustria do Norte e Nordeste-PROTERRA (Program for Land Redistribution and Incentive for the North and Northeast Agroindustry). The objectives of this program were to promote in Amazonia Legal and Northeast region (1) a greater access to land by the landless, (2) better employment conditions, and (3) agroindustries. A total amount of c.a. US$ 1.75 billion was allocated to the program to be used for (a) acquisition of expropriated land (and covering its operational costs) by the government for later sale to small farmers, (b) credit lines to those small farmers for land acquisition,[14] (c) credit lines to agroindustries, (d) financial allocations to organizations supplying services like research, storage facilities, marketing, transportation, electric energy; (e) the subsidization of agricultural inputs; (f) the support of minimum price policies for export products; and others. This large amount of resources would come mainly from the Union's budget, from PIN, and from an additional 20 percent reduction in the amount of resources available from all fiscal incentives programs during the fiscal years 1972-1976[15].

The combination of this percentage with the 30 percent of the fiscal incentives funds already being used by PIN law (which was also extended until the end of 1976) represented a reduction of 50 percent of funds available to SUDAM to finance projects[16]. Figure43 above illustrates the effects of these reductions on the amount of investment approved by SUDAM.

As one might expect, the creation of PIN and PROTERRA did not

generate much criticism from AEA. Indeed, AEA praised the government for its road building initiative, which had been in the past one of the basic demands of the association. AEA also expected to benefit from the greater availability of migrants to be part of the labor force in those parts of the region (Pompermayer, 1979: 232-3). But the new Médici Amazonia strategy was not all approved by the Southern investors. The fact that INCRA now controlled the great majority of land in the region and that INCRA's priority to land allocation was for distribution to small farmers did not appeal to the association's members. In fact, this basic difference in the priorities for Amazonia land allocation became the main source on intra-bureaucratic disputes between INCRA and the Ministry of Agriculture on the one side and SUDAM (which supported AEA's stand point), the Ministry of the Interior and the Ministry of Planning on the other side (Pompemayer, 1979: 244-54).

The Scheme

The Transamazonica highway connected two cities in the Northeast--Cabedelo and João Pessoa--with the Brazilian frontier town of Cruzeiro do Sul-Acre on the Peruvian border in a total length of 5,560 km. Construction on the stretches from the Northeast up to the Belém-Brasília Highway and from Humaitá to Cruzeiro do Sul were already partially completed when the new highway was announced. Therefore, it has been considered as Transamazonica itself the road stretch going from Estreito in Maranhão to Humaitá in Amazonas in a total of 2,322 km. Construction of the road started at full speed a few months after

the creation of PIN, in September of 1970. The first stretch between Estreito and Itaituba (1,266 km) was finished in 1972 and the final portion between Itaituba and Humaitá (1,056 km) was completed in 1974 (Wagnievicz, 1974; Smith, 1982: 12).

The agricultural colonization part of PIN was soon to follow. Government authorities were quick to announce that the soils of Amazonia were good for agriculture, despite the fact that there was already at the time substantial evidence to the contrary (Passarinho, n.d.: 151; Tamer, 1971). For instance, Minister of Agriculture, Cirne Lima, after a visit in October, 1970 to the area where the Transamazonica met the Belém-Brasília, stated that "the (agricultural) harvests (here) are larger than in the northwestern part of Rio Grande do Sul, Santa Catarina and Paraná"[17]. These lands in Southern Brazil are the most productive farming areas of the country.

Unlike the spontaneous colonization that occurred on the Belém-Brasília, Transamazonica colonization would see heavy public intervention. The government began a large-scale propaganda campaign on radio, television, and the press to attract settlers from several parts of the country to colonize the new highway. On the lands along parts of Transamazonica, the government prepared an elaborate and expensive scheme for the colonists. Initially, colonists were provided with air transportation to the colonization sites where they would receive a 100 ha plot of virgin forest land with a four-room modest wooden house, monthly minimum wage for the first six months, technical assistance, credit at low interest rates, production inputs such as seeds and

fertilizer, minimum price guarantee for their agricultural production, feeder roads, school and health services, and they would be able to buy food at low prices from government suppliers. (Arruda, 1976: 51-2; Moran, 1983: 303; Smith, 1982: 17; Wood & Schrmink, 1978: 80-1).

All those benefits to the colonists would be provided within the framework of what INCRA officials called _Projetos Integrados de Colonização_-PIC (Integrated Colonization Projects)[18]. Three of these projects were created on the first portion of the highway: Marabá, Altamira, and Itaituba[19]. According to the original plans developed by INCRA, a new agriculture colonization approach was to be used for the first 10 km strip on each side of Transamazonica, this was the so called rural urbanism. The other 90 km on each side of the road were to be sold by INCRA through public bidding in lots varying in size from 500 to 3,000 ha for medium-sized farms and cattle ranches (Fearnside, 1984: 49; Smith, 1982: 16).

Rural urbanism consisted of a series of hierarchical communities to be built by the Institute so as to achieve social integration in the rural area. At the bottom of the hierarchy were the _agrovilas_, a 48-66 house community to be located at every 10 km along the Transamazonica and main feeder roads. There, INCRA would have an office, it would include an elementary medical post, a general store run by the _Companhia Brasileira de Alimentos_-COBAL (Brazilian Company for Food), an office for the rural extension service, and a soccer field. At every 20 km a secondary level community, the _agropolis_ was to be built as an urban center for up to 600 families

and with a cooperative, secondary and elementary schools, bank and post office. At the top of the rural urbanism hierarchy was the ruropolis. This was the largest unit and was to be built at about 140 km intervals to serve as administrative headquarters and was to include airport, hospital, banks, hotels, restaurants, telephone and other services. It would also include some supportive agroindustries (Arruda, 1976: 48; Moran, 1981: 147; Silva, 1975; Smith, 1982: 19-20; Wood & Schmink, 1978: 80).

Failure of the Scheme

The success of this expensive new policy for Amazonia has been very limited. The Marabá Integrated Colonization Project was substantially curtailed due to the high incidence of Malaria while PIC Itaituba was curtailed by the presence in its site of very poor soils. PIC Altamira, due to the presence of patches of terra roxa soils (Alfisols) found immediately west of the city, was selected as a show case for the execution of Transamazonica highway colonization (Moran, 1983: 302-3). But, as later soil research indicated, only in 3 percent of the highway transect could terra roxa be found. And even so, these soils were not homogeneously of that classification which resulted in differential results to colonists (Moran, 1983: 303-4; Smith, 1982: 80).

The rural urbanism scheme also failed to emerge. From the 66 agrovilas originally planned between km 20 and km 70 west of Altamira, only 27 have been erected and most of those erected did not have the promised amenities. Even in those constructed, many of the houses were

abandoned by the colonists who preferred to move their residences to their lot sites in order to avoid family separation and time wasted by travelling back and forth. From the 15 agropoli planned for the Marabá-Itaituba portion of the road, only 3 (Brasil Novo, Amapá, and Miritituba) have been built. None of the three agropoli have prospered. Agropolis Miritituba has been virtually abandonned while Agropolis Amapá and Brasil Novo have been reduced to almost exclusively administrative centers for INCRA. Only one ruropolis has been built, Medicilândia. Due to its strategic location at the junction of the Transamazonica and the Cuiaba-Santarém highways, Medicilândia has survived but as a much smaller community of only about 600 inhabitants, much smaller than INCRA had planned (Smith, 1982: 24-7; Wood & Schmink, 1978: 81).

Financial cost figures for the PIC program have been difficult to come by. It has been estimated, however, that each agrovila has cost the government around US$ 425 thousand (1982 prices) and the cost for each colonist, not including INCRA's administrative cost, has been c.a. US$ 13,000 (1982 prices) (Cardoso & Muller, 1977: 197; Silva, 1975: 29, 31).

The Transamazonica highway has been essentially abandonned after its completion. Today it is a narrow dusty road during the dry season and during the rainy season highway traffic has been frequently interrupted due to mud, washouts, or bridge collapse. Maintainance has been very limited (Bunker, 1982: 579).

The apparent major motivation for the creation of PIN and

Transamazonica as a safety-valve for solving Northeast "overpopulation" problem also failed to work. Northeasterners, for the most part, continued to see South Brazil as a better region to move to. In fact, by 1975 it was estimated that only 30 percent of Transamazonica colonists were from that drought striking region while initially their participation was officially expected to be 75 percent. Caboclos made up another 30 percent of the existing colonists while South and Southeast immigrants, 23 percent, and those from Center-West region accounted for 13 percent (Moran, 1981: 304-5; Smith, 1982: 24). In addition only 7,900 families out of a total of 100,000 projected for the first five years by the government had been settled on Transamazonica by mid-1978 (Skillings & Tcheyan, 1979: 72)

Various reasons for these failures have been discussed by students of this agriculture colonization program including the bureaucratic operational problems of design and implementation of the projects; the annual crop bias of credit programs available to colonists; the little or no prior agricultural experience of many colonists who came to the region with land speculation in mind; health problems; transportation problems, and poor agricultural productivity (Bourne, 1978: 184-8; Bunker, 1982; Moran, 1981; Smith, 1981; Smith 1982; Wood & Schmink, 1978).

Among those reasons the poor agricultural productivity has certainly been a determinant factor. From the 100 ha originally given to colonists by INCRA, only 50 ha could be legally clearcut, as required by the New Forest Code[20]. Smith (1982) has found that on

the average, a colonist in Transamazonica cleared some 8 ha per year. Annual crops such as rice, corn, beans, were then usually planted in the area for a period of only one or two years. Due to the typical falling productivity of annual crops on poor soils, colonists would then leave the land to lie fallow after a couple of years under second growth or they planted pasture, a land use which has become increasingly popular choice in the region. Besides the benefit of assured land control, as required by the Estatuto da Terra, this type of land use has been seen as a measure to increase the sale-value of the land. But much of those pasture lands suffer with the same problems that SUDAM supported cattle projects face. Among others, they are choked with second growth due to the difficulty and costs of weeding. In addition to loss in soil fertility through lixiviation and the invasion by weeds; erosion, plant diseases and pests have been reported to be reasons for the decline in agricultural productivity and testify to the poor sustainability of agricultural production, specially of annual crops, in most of the region in the absence of substantial agricultural inputs[21]. (Fearnside, 1980: 1292; Fearnside, 1983; Goodland, 1980: 17; Moran, 1981: 143-4; Smith, 1981: 757-9; Smith, 1982: 46-52).

These poor outcomes of Médici's small farmer agricultural colonization along the Transamazonica combined with a series of events occurring at the end of his term and the beginning of the next government resulted in a substantial change of Amazonia policy by the next president of the revolution.

V.3 POLAMAZONIA, Private Agricultural Colonization, and Large Projects.

President Médici, in consultation with top military officials, selected general Ernesto Geisel as Brazil's next president. Various factors contributed to a substantial change in Amazonian Development Policy with the arrival of the new administration in March of 1974. The poor performance of the Transamazonica colonization program and the increasing criticism of the program by AEA, SUDAM, the Ministry of the Interior-MINTER, and the Planning Ministry are major instances. J.P. Reis Velloso, Minister of Planning of the Médici government, for instance, after a tour of Transamazonica in the company of twenty southern enterpreneurs, members of AEA in August, 1973, declared in a speech in Belém that the government was changing the development strategy of the region from colonization to large enterprises. Minister Velhoso, ironically, justified the need for such a change as a means to avoid the predatory occupation, with deforestation, observed with small farmer official colonization and to promote the maintenance of ecological equilibrium (Cardoso & Muller, 1977: 158; Kleinpenning, 1978: 82; Pompermayer, 1979: 250-1).

Besides the intra-bureaucratic conflict over Amazonian development strategy in the previous government, the Geisel administration was also facing the first oil crisis provoked by the

cartel of oil producers in 1973. Brazil, at that time, depended heavily on oil imports to supply the country's needs. The oil price increases would result in a general increase of transportation and other costs and deteriorate the country's balance of payments. Partially as a consequence of these price increases, the high rates of growth of the "Brazilian Economic Miracle" *period* started to show signs of decline indicating its emminent end. The combination of those factors led to substantial changes of strategy for the development of Amazonia by the new government.

Those changes, in fact, reminded one of the original strategy promoted in Castelo Branco's Operação Amazônia of nearly 10 years earlier. As Reis Velloso, who continued as Planning Minister in the Geisel Administration, had indicated, the small farmer official colonization emphasis was to be substituted by the promotion of large enterprises, including cattle ranches. For this, SUDAM's fiscal incentive and credit policies--including PROTERRA's--were to be adjusted. Drawing from a Estatuto da Terra provision, colonization now was to be conducted by the private sector instead of by INCRA. The institute was now to concentrate on the tasks of separating public and private lands by surveying--a process known as land discrimination--giving legal title to posseiros and alienating public lands to the private sector. These tasks have dominated INCRA's portion in Amazonia since then. Finally, substantial portions of PIN and PROTERRA resources were diverted from their original objectives to finance a new program for the region based on the concept of

development poles, a strategy also mentioned in the Operação Amazônia legislation. The Programa de Polos Agropecuários e Agrominerais da Amazônia-POLAMAZONIA[1] (Amazon Agricultural and Mineral Poles Program) intended to invest c.a. US$ 788 million during the period 1975-79 in infrastructure and the promotion of productive activities in 15 selected poles. POLAMAZONIA was the most important part of the changes brought by the Geisel Administration in terms of Amazonian Policy.

Private Colonization

The disputes between INCRA vs SUDAM/the Ministries of the Interior and Planning about the government strategy for Amazonian development were settled with the arrival of President Geisel in the government. The criticism of INCRA's official colonization program by the AEA and SUDAM was better summarized by the Superintendency in its II Plano de Desenvolvimento da Amazônia-II PDA (SUDAM, 1976a; 1976b)[2]. In harmony with the new Geisel policy that it helped to shape, SUDAM criticized in this document the Médici's small-farmer agriculture colonization approach by stating that it promoted large spontenous immigration to the region (although not necessarily to Transamazonica). These immigrants, according to SUDAM, were poorly educated, with no capital to invest, who knew only the most rudimentary agricultural methods and dreamt of finding fertile soils. Instead of contributing to the development of Amazonia, they indeed exacerbated problems for the region such as need for (1) provision of jobs, (2)

regulation of the land possesion situation, (3) more public services (education, rural extension, credit, and guaranteed prices for a high cost agriculture), (4) more infrastructure, and (5) more efforts to prevent the distruction of natural resources (SUDAM, 1976b: 13). With arguments like these, many of which were first used by AEA, and combined with the factors mentioned above, SUDAM, MINTER, Planning Minister, and AEA were successful in substantially changing INCRA's mandate in the region.

Colonization in Amazonia was now to be undertaken by the private sector. This approach was not entirely new in the region. It was already present in the Estatuto da Terra and drew from the experiences of colonization projects conducted by private enterprises in Southern Brazil (Foweraker, 1981; Nelson, 1973; Tavares et al., 1979). In fact, by the end of the Médici administration there existed already some private colonization in Amazonia (Arruda, 1976).

But there was still a source of intra-bureaucratic disputes with the new policy. For it to be successful, more terra devoluta would have to be made available to the private sector to undertake the projects. INCRA was still the government agency which controlled all federal terra devolutos in Amazonia. The MINTER, early into the new administration, proposed to Geisel "the creation of two semi-public companies 'to administer, rent and alienate the lands of the region,' tasks up to then the responsibility of INCRA, and to 'administer biological reserves, national parks and forests,' a function currently under the jurisdiction of the IBDF ... . Finally, the companies would

also administer Indian reserves, previously the task of FUNAI (a dependency of MINER (sic))" (Pompermayer, 1979: 261). The proposal was never accepted by Geisel, but the mounting pressures on INCRA from SUDAM, MINTER, Planning Ministry, and AEA did partially accomplish their intent.

INCRA, now under new leadership, started not only to accelerate the pace of land sales (1,000-3,000 ha tracks) but also to increase the size of each sale which was limited by the constitution to a maximum of 3,000 ha. Since sale of terra devoluta above this limit was conditional on previous Senate approval, INCRA had to obtain congressional authorization. This authorization came in mid 1976 with the approval of INCRA's Special Instruction no. 11 and no. 12 allowing the Institute to alienate federal lands to private enterprises. INCRA could now sell up to 500,000 ha of land to licenced private colonization companies to be divided and sold in lots varying from 100 to 500 ha each (Special Instruction no. 11). Special Instruction no. 12 showed an extra victory to AEA and its allies by allowing INCRA to sell up to 66,000 ha of terras devolutas to private companies to develop cattle enterprises and up to 72,000 ha to develop forestry projects[3] (Arruda, 1976: 59-64; Foweraker, 1981: 162-3; Pompermayer, 1979: 262-5).

To further promote private colonization by enterprises, the Geisel administration reduced the Rural Land Tax (ITR) that those companies would have to pay for the large land tracks sold to them by INCRA. Special subsidized rural credit lines using resources from PIN and PROTERRA were also used to incentivate private colonization. As

the Operação Amazônia legislation permitted, SUDAM increased its support to private colonization projects through the fiscal incentives program (Arruda, 1976: 59-64; SUDAM, 1976: 43).

Pompermayer (1979) suggests that those benefits combined with the manner in which these projects were executed resulted in substantial profits to those companies. This author describes the execution of those projects:

> The plots of 100 to 500 hectares into which the land is then divided are sold to interested colonists and the enterprise receives total payment on sight. The colonists, on the other hand, has to pay 20 percent of the cost of land with his own money, with the PROTERRA program of Bank of Brazil advancing him the payment of the other 80 percent. While the enterprise receives 100 percent of the cost of the land on sight, the colonist mortgages his land to the bank and is compelled to find other financing for production (acquisition of tractors, for instance) in order that he may pay back the credits advanced. It is a notorious fact that the most probable consequence of this kind of operation for the peasant is continuous indebtedness to the banks, leading to loss of the land for lack of resources or its sale to more fortunate farmers. By contrast, the enterprise's profits are secure; after constructing the basic infrastructure and selling the plots, it simply leaves the area and starts another project (Pompermayer, 1979: 282).

Unlike the official agricultural colonization projects, private colonization does not benefit the poorest of the landless peasants since the colonists have to have some initial savings to pay the down payment and become elligible to credit. Private colonization has been in fact served to relocate <u>minifundistas</u> in Southern Brazil who sell their small land plots and use the revenue to buy land in Amazonia. The group of immigrants which was the objective of the Médici administration, the poor Northeast peasants, are not likely to

participate of the new agricultural colonization strategy for lack of resources (Pompermayer, 1979: 283-5; Ulman, 1984).

Already by 1977, INCRA had registered 32 colonization projects submitted by 20 enterprises, almost all of them located in northern Mato Grosso, including along the Cuiaba-Santarém Highway*. Private colonization projects have not succeeded in substantially changing the role of INCRA in promoting official colonization in the region. By mid-1978, these private enterprises were responsible for the colonization of less than 10 percent of the number of families settled by the government-administered projects (Skillings & Tcheyan, 1979: 84). Since 1980 when private colonization reached a peak of almost 10,000 settlers, the number of new colonist settled by these companies has decreased to 2,491 in 1982, essentially because of the changes in credit policy limiting the amount of resources lent for land acquisition and for infrastructure (INCRA, 1983: 14-5). Another factor influencing the role of private colonization in Amazonia is the relative availability of "free" land to migrants through INCRA as well as the use of posseiro practices which have increased in the region.

Like cattle farming in Amazonia, this type of private colonization project with all its subsidization can be substantially profitable in financial terms to the Southern enterpreneurs. Unfortunately, there is little information about the medium and long term financial results to the colonists. Based on the information about the nature of Amazonian soils and the previous agricultural colonization attempts in the region, the prospects for financial

success for most of those colonists are small, leaving them with an uncertain future. Perhaps, many will need further subsidies in the future years to survive.

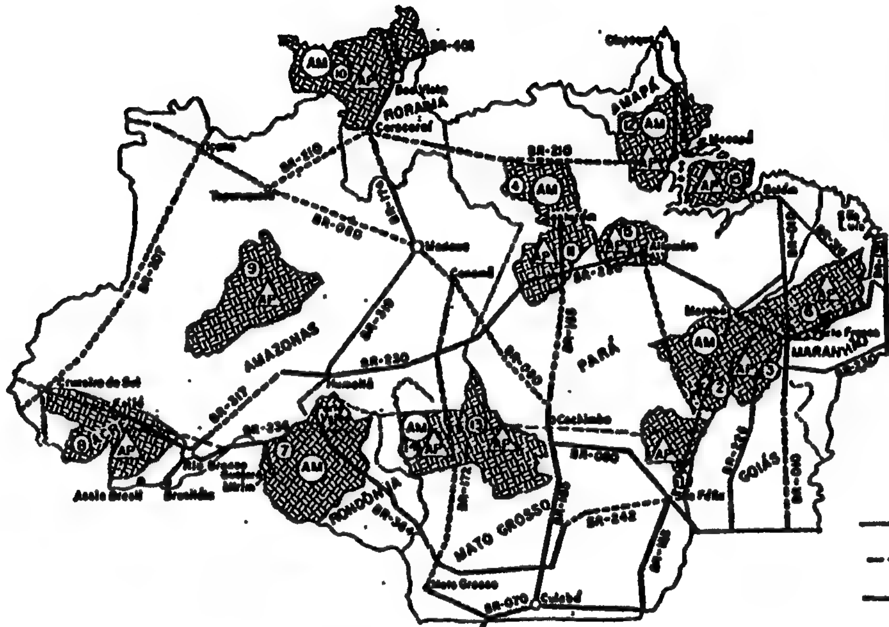
Also, like cattle farming in Amazonia, agricultural colonization (official or private), in addition to the costs to the Brazilian society of the credit and fiscal subsidies which sustain them in the region, also result in other social costs that Brazilians are paying. The irreversible conversion of the tropical forest to other land uses (or misuses) results in loss of the small quantities of nutrients previously stored on the forest biomass by erosion and lexiviation. This implies losses of land productivity which can be recuperated only by the introduction of expensive inputs to the land or by long fallow periods. In addition there are possible losses of biological diversity which represent social cost not only to Brazilians but also to the rest of humanity. Other consequences of deforestation on a more regional or world scale such as increase in carbon dioxide and climate changes have also been mentioned in the literature as possible outcomes to this process, as further discussed below.

By letting colonization become the responsability of the private sector, Geisel was able to shift the emphasis of his policy towards the region from the basic approach used by the Médici Administration to a new one. Amazonia was seen by his administration not as the safety valve for Northeast problems, but rather as a region with great potential to contribute to the growth of the country's GNP and to the

generation of foreign exchange to help with Brazil's balance of payments difficulties. The II Plano Nacional de Desenvolvimento-II PND (II National Development Plan) for the period 1975-79 established that the strategy to be followed to achieve the Amazonian potential was through the concentration of governmental action and investment in selected areas of the region. These areas, or poles, were chosen for the comparative advantages that they had in relation to their strategic location and potential for investments in mineral, cattle, forestry, and agroindustrial production. To put to effect the new approach, Geisel approved the creation of POLAMAZONIA in September, 1974. This program defined 15 growth poles in which the federal government would concentrate its investments so as to create a more favorable investment climate and induce the private sector to invest in the areas through fiscal incentive and credit policies.

Government investment in the region would concentrate in those poles through the provision of economic and social infrastructure such as roads, airpots, ports, energy (including hydroelectric), urban services, communications, agricultural research, and others. Funds in the amount of US$ 788 million (1982) for POLAMAZONIA were obtained mainly from the resources originally allocated to PIN and PROTERRA. Although the growth poles approach was not new in the region, it was inovative in the sence that the poles chosen were not associated with urban areas as they were in the previous plans (CDE, 1974; Mahar, 1979: 26-8; SUDAM 1976a; SUDAM, 1976b). Figure 49 locates the 15 growth poles created.

Figure 49: Poles of the POLAMAZONIA Program.



Poles

1 – XINGU-ARAGUAIA (MT)
2 – CARAJÁS
3 – ARAGUAIA-TOCANTINS (GO)
4 – TROMBETAS
5 – ALTAMIRA
6 – PRÉ-AMAZÔNIA MARANHENSE
7 – RONDÔNIA
8 – ACRE
9 – JURUÁ-SOLIMÕES
10 – RORAIMA
11 – TAPAJÓS
12 – AMAPÁ
13 – JURUENA
14 – ARIPUANÃ
15 – MARAJÓ

Roads

Paved
Paving
Unpaved
In Construction

AP - Agriculture and Cattle

AM - Agriculture and Mineral

Source: Adapted from Costa, 1979: 63.

Log Supply System

POLAMAZONIA was but one of a series of investment programs described in the II PDA. Another of them included an interesting proposal by SUDAM to organize wood production in Amazonia. Traditionally, log production in Amazonia has been based on the narrow várzea strip along some of the regions rivers. This was a consequence of the almost complete absence of roads in the region for the first centuries of its history. As logs are bulky and heavy, only an average of 500 m on each side of a river has been usually exploited. Caboclos, under a system similar to the aviamento where logs are exchanged for city products or sold, fell a few tree species using axes on the várzea forest upstream from the mill. The ownership of these forests are in most cases unclear and the logs are simply obtained with little regard to the property rights of potential land owners. With the rise of the water level during the rainy season, the caboclos can float the logs out of the várzea onto the closest main river where it is exchanged with local operators. The logs so obtained are then formed into small rafts to be towed to collection points where they are reassembled into large rafts for towing to the downstream mills. In some cases the local operator is a company agent, but in the majority of the situations, it is an independent log supplier contracted by wood industry mills and operating in a fashion very similar to the regatão discussed before.

For this type of wood supply system, logs have to be of

relatively low density so as to allow floatation. Heavier logs may also be transported on top of the floating ones. However, floating logs absorb water through their extremeties with time and can sink. Wood losses in this system are common. Mercado (1980: 44) has estimated that as much as 60 percent of the original raft wood volume may be lost before delivered to the mill. These losses are acceptable by the independent or company supplier due to the low cost of this supply system. In fact, although a transportation system consisting of a tug boat and barge which avoids log losses has been available for some time, its use has been limited due to its relatively high cost per log volume transported.

This system of log supply to wood industry mills in the region has been dominant thoughout the region's history. With the appearance of roads which began in the late 1800s, it has slowly decreased in importance for some locations. These roads have increased the access to terra firme forests. However, this system is still the most important for the wood industries in the state of Amazonas where it was estimated to be responsible for the supply of as much as 89 percent of their log consumption in 1978. In Pará, despite the presence of the Belém-Brasília, Transamazonica and other state highways, water transported logs still comprise as much as 80 percent of the logs processed in that state. The wood industries in Acre, Rondonia Mato Grosso and Roraima, however, are dependent on roads for log transportation in as much as 100 percent. For the Amazon region as a whole, water transportation still represents 68 percent of the log

volume used by wood industries (Gregersen & Contreras, 1979; IBDF, 1982a; Knowles, 1971: 30-3; Mercado, 1980: 41-4; Pandolfo, 1977: 23, 25-8, 34; Stahelin & Everard, 1964: 22-3).

Besides the substantial loss of wood that the water transportation system generates, this system has other drawbacks. It is a seasonal activity since logs can be floated out of the várzea only in the wet season. This implies that the mills dependent on this type of log supply system has to operate substantial log storage to be able to produce throughout the year. Due to the high capital investment that this stock piling represents, estimated to vary from 50 to 70 percent of the mill's production costs, only the larger and financially stronger companies are able to do so. In point of fact, lumber output in the region usually declines as much as 30 percent during the dry season due to lack of logs. Others suffer substantial reduction of the installed capacity utilization and in some cases they may even cease to operate completely*.

Another drawback of wood supply system is the small forest area that it makes accessable to wood exploitation. This in fact has been reflected in the increasing distances that log suppliers have to travel to obtain the logs they need. This is also a result of the small number of species which are actually exploited from the varzea and the consequent low volumes per hectare of forest. Log suppliers to wood industry mills in the state of Amazonas have to travel more than 600 km for about 50 percent of the logs they supply. In some cases log suppliers have to travel as much as 2,000 km to obtain the necessary

logs (IBDF, 1982; Mercado, 1980).

Pandolfo's Proposal

Realizing some of these problems and considering other aspects of the forest-based sector in Amazonia, SUDAM proposed in the II PDA the creation of a program for the rationalization of wood exploitation in Amazonia. This program was based on an idea that the Natural Resources Department of SUDAM had been developing since the early 1970s. It was further detailed in a publication by the director of that department, Clara Pandolfo published in 1977 (Pandolfo, 1977). Although the program was never actually undertaken, it is important to summarize its approach since it has been frequently referred to in Amazonian forest policy discussions (Reis, 1979; Valverde, 1982). This program became the first official proposal for a forest policy for Amazonia made by the federal public sector[7].

The Pandolfo proposal[8] recognized that (1) the majority of the soils of the Amazon region were poor in natural fertility and acidic making them inappropriate for most types of agricultural productivity; and (2) most of the region was covered by tropical forests with substantial wood resources. These basic features of the region, according to the proposal, showed clearly that the natural vocation of Amazonia was wood production and not agricultural production. From those two basic facts, Pandolfo argued that, therefore, the best land use pattern for Amazonia would be the one in which most of the land was allocated to forest exploitation activities

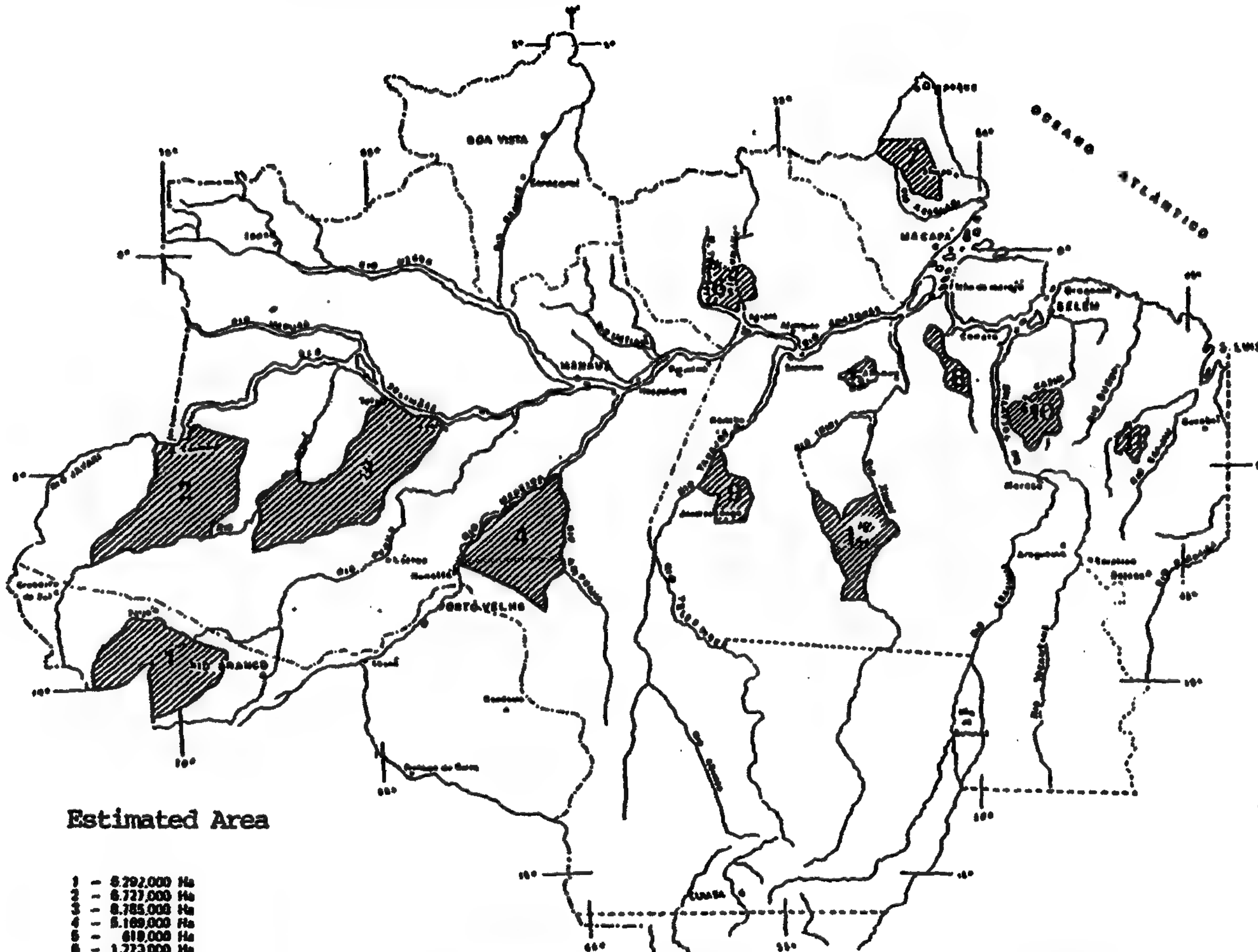
(mostly wood production) while agriculture should be restricted to the patches of fertile lands. To achieve such pattern, the proposal suggested that the region be zoned into major basic land uses such as land appropriate for agricultural colonization, agricultural and cattle production, preservation units (national parks, biological reserves, ecological station), Indian reserves, and productive forests[9].

The bulk of the proposal concentrated on the productive forests, called in the study Florestas Regionais de Rendimento-FRR. SUDAM suggested that initially 12 FRRs be created in selected terra firme forest areas of Amazonia, amounting to almost 40 million ha, for the sustained production of wood. Figure 50 shows the location of these forests and their respective sizes. It was anticipated that, eventually, the FRRs should reach at least 50 million ha, which roughly corresponded to 20 percent of the estimated total forested area of the region.

The FRRs were to be kept under federal government ownership and rented to national or foreign private wood companies by concessions for exploitation. These companies would be incentivated to locate in the FRR not only by the financial advantages of location near the bulky and heavy raw material source, but also through credit and fiscal incentives[10].

The complete scheme of activities attributed to the private and public sectors was not clearly stated in the proposal and at times it was ambiguous. The public sector would not control those forests neither through SUDAM nor IBDF, but rather through a new organization

Figure 50: Location of the Florestas Regionais de Rendimento Suggested by SUDAM.



Estimated Area

1 - 8.292.000 Ha
2 - 6.727.000 Ha
3 - 8.785.000 Ha
4 - 5.169.000 Ha
5 - 618.000 Ha
6 - 1.773.000 Ha
7 - 1.538.000 Ha
8 - 1.193.000 Ha
9 - 2.197.000 Ha
10 - 1.585.000 Ha
11 - 726.000 Ha
12 - 2.900.000 Ha

Source: Adapted from Pandolfo, 1977: 21 after SUDAM.

structured as a mixed enterprise,[11] controlled by the government but also owned by private individuals. This organization, called hereafter Forest Enterprise, would administer all those forests. This included nearly all log production activities and forest management. It was not clearly stated where the responsibility of the Forest Enterprise would end and the private company would begin. The only activity that the Forest Enterprise would apparently not execute would be wood industrial production. In this case the Forest Enterprise would supply logs to the wood product industries on their own logyard for an arranged price. However, this would not limit the participation of the Enterprise in establishing wood products entrepots where wood product stocks would be kept, and selection, classification, drying operations, and quality control would be undertaken. The Enterprise would also be involved in the marketing promotion of new wood species in foreign markets. Other parts of the proposal give the impression that the Enterprise would perform some basic pre-exploitation activities such as forest inventory of concession lots, road building, then it would supervise the log exploitation by private companies under contractual constraints about technology to be used and finally, the enterprise would execute silvicultural activities to assure the long term sustainability of wood production in those lots.

The proposal estimated that this arrangement would supply, with wood products produced with logs from FRRs and the local and the rest of the Brazilian internal market, 30 percent of the international consumption of tropical wood products within 10 years of operation.

This ambitious goal would represent a substantial contribution of the Amazon region to the trade balance of the country.

The wood industrial complex anticipated by the program to be located in these forests, combined with forest activities and associated indirect economic activities, would also generate income to numerous workers. These workers would form urban communities which would become the basis of an alternative to the several unsuccessful attempts at colonizing the region via agriculture: forest colonization.

A final attribution of the forest Enterprise would be to harvest forest areas that were going to be converted to non-forest land uses such as agricultural colonization projects or cattle raising farms, so as to avoid the substantional wood losses that were occuring in those conversions. In those areas, the enterprise would undertake salvage logging.

The proposal was very preliminary and in certain respects difficult to implement. But it did represent the first major attempt in the history of the region that an agency of the government tried to use the abondant forest resources of Amazonia as the basis for the development of the region. The reasons for the non-execution of the proposal have not been clear. The poor relations between SUDAM and IBDF at the time, perhaps, has something to do with it[12].

IBDF's Study and Forest Crisis

In 1978, IBDF published a study about the possibilities of establishing a system of forest utilization contracts on public lands of

Amazonia. The study,[15] written by F. Schmithusen, a FAO expert, recommended the utilization in the region of a system of long term (10-20 years) utilization contracts in which selected forest areas (300 to 500 thousand ha) would be institutionalized as national forests under federal government control. Forest inventories would then be conducted by the government to determine the availability of wood raw material. The results of those inventories would be made public so as to allow interested private corporations to prepare proposals for their utilization in industrial activities. Selected private companies would, with the assistance of the public sector, prepare more extensive feasibility studies. Negotiations of the terms of a concession contract would follow. This contract would, in general terms, establish that the private companies would be responsible for forest exploitation activities under specific conditions and supervised by the government.

The companies would have to pay two types of fees for the privilege of exploiting the national forest. The first would be forest fees to be paid on the volume of logs harvested. This fee would represent a portion of the residual value of the log and would vary with the wood species and could be adjusted over time to account for changes in wood product prices as well as for changes in the production costs. The second type of fee would be charged to the companies to cover the public sector costs with the operational of the national forest such as forest inventories, supervision costs, silvicultural costs to assure the sustainability of the log production, and

administrative costs.

This resolution (articles 25-31) also affected the requirements for the approval of wood products industrial projects making them relatively more difficult to be complied with. SUDAM decided to demand that these projects with projected installed capacity superior to 15,000 m^3 $year^{-1}$ include the management of forested areas for the supply of their raw materials. Doubtlessly, these requirements were related to the program of Florestas Regionais de Rendimento that SUDAM proposal in the II PDA, as discussed above, but which was never approved by the president. Unlike that proposal, these requirements are law. Although SUDAM's resolution allowed the use of forested land belonging to third parties or to the project proponents, the fact that most forest areas are in a terra devoluta status and the undecidedness of the federal government with respect to a forest policy for the region, has made it difficult to obtain control over forested areas and, thereby, to comply with SUDAM's requirements. In addition, the forested area required by SUDAM for the approval of this type of projects should be managed for the production of at least 30 percent of the raw material needed in the first year of operation of the plant and this proportion should increase thereafter. The management plan for the forested areas should include forest inventories, descriptions of mechanized harvesting and transportation operations, as well as silvicultural operations required to be performed in the harvested areas to improve natural regeneration of the forest. Although those requirements, in principle, are sound, they may represent increased

burden for the preparation of these projects especially in light of the fact that some of these requirements were difficult to justify in a financial evaluation.

These aspects are especially relevant when consideration is given to the much less restrictive requirements written in this resolution for other types of projects which irreversibly convert forested areas to other land uses. Therefore, this requirement probably affected the willingness of private individuals to develop wood products industrial projects to take advantage of SUDAM's fiscal incentive program. Unfortunately, no analysis of these policy changes has been made so far to evaluate the impacts of the resolution.

Emphasis on Mining

As a part of President Geisel's policy towards Amazonia, support for large projects, especially in the mining sector, was also emphasized. A discussion of this new emphasis on the mining sector is presented here for various reasons. Mining and related processing activities have grown dramatically in importance as an economic activity in Amazonia. Large amounts of capital have been invested in this activity and the prospects for its increased participation in the regional economy has further increased with the creation of the Greater Carajás Program which is discussed in more detail in the next chapter. This growing importance of the mining section is important for the forest-based sector because (1) it represents greater pressures on forest resources due to increased migration to the region, facilitated

by new and improved access, (2) of increased energy demands for forest-based energy--fuelwood and charcoal--from native forests and forests to be planted, and (3) of increased energy demand for electricity resulting in the construction of a large hydroelectric power station in the region and planning for others--hydroelectricity is closely related to the forest-based sector.

The mineral resources found in late 1960, by the RADAM project financed by PIN and other surveys, were now initiating a new phase of exploitation. The minerals found in the region included bauxite (the ore of aluminum), iron ore, gold, copper, manganese, nickel, and tin. The two new major minerals which received large amounts of investments were bauxite and iron ore. Investments for their exploitation in large scale started in this period and production has began recently.

Bauxite was discovered by the Aluminum of Canada Company-ALCAN in the late 1960s. By 1971, ALCAN had estimated the reserves of this ore in an area of the lower Trombetas River near the city of Oriximiná, Pará, to be in the order of 600 million tons. Although this company started a mining operation there in 1971, it would be only in 1975 that a major project actually started[18]. This time the project was developed by a consortium of companies, Mineração Rio do Norte-MRN, then under the leadership of the Brazilan state corporation Companhia Vale do Rio Doce-CVRD. CVRD, which was created by President Vargas in 1942 and is currently under the jurisdiction of the Ministry of Mines and Energy, detained 46 percent of MRN while other Brazilian private companies have another 10 percent. The other 44 percent is

under the control of 6 foreign companies; ALCOA detains 19 percent of the total investment.

The mining operation started in 1979 with the production of 620,000 tons in that year. The operation is done in an open pit mine and bauxite is transported through a 30 km railroad to a company port on the Trombetas River where an ore-improvement plant is located. From there this excellent quality bauxite was exported.

Since Brazil has been an importer of aluminum, it was the intention to explore the possibilities of the industrialization of the ore in Amazonia. Energy is a major input in the aluminum industry, thus, the first oil crises in late 1973 resulted in a substantial increase in the production costs of alumina and aluminum in most operations in many countries. The existence of a domestic market and large ore reserves,[19] combined with relatively good location and port facilities, as well as the potential availability of cheap hydroelectric energy in western Amazonia, made this area an excellent region for the development of industrial complexes for the production of this metal.

The first project for the production of alumina in Amazonia is that of the Alumínio do Norte do Brasil SA-ALUNORTE. This company, located at Barcarena near Belém on the mouth of Tocantins River, is also controlled by CVRD (60.2 percent) with the balance of its capital subscribed by a Japanese consortium of private and public sector orgainzations, NALCO-Nippon Amazon. ALUNORTE will process bauxite from the MRN Trombetas mining project to produce initially (1984-1985)

800,000 tons of alumina per annum and eventually up to 2.4 million tons per annum. Investments on this project amount to US$ 571 million (December 1979 prices). Also in Barcarena the same two groups--CVRD (51 percent) and NALCO (49 percent)--are building an aluminum plant to produce, at full capacity, 320,000 tons of the metal per annum using alumina produced by ALUNORTE. Forty nine percent of the production of the Alumínio Brasileiro SA-ALBRAS is to be marketed in the international market by the Japanese partner. Investments in this facility amounts to US$ 1.3 billion and production is expected to begin also in 1984-1985.

Another industrial project using bauxite from the Trombetas River area is that of the association of ALCOA with 60 percent of the capital and Billiton Metals--a subsidiary of Royal Dutch Shell--with the balance: ALUMAR. This totally foreign owned company involved investments of US$ 1.3 billion. Construction of this plant, which is located near São Luiz in the state of Maranhão, initiated in 1980 and its first production phase was inaugurated in August, 1984. All ALUMAR's output, 110,000 tons of aluminum and 500,000 tons of alumina, is being sold in the international market. ALUNORTE, ALBRAS, and ALUMAR are the first three aluminum industrial projects in western Amazonia and some others are being studied (Almeida, 1978: 15-6; Anonymous, n.d.: 39-41; SUDAM, 1976a; Teixeira, 1984).

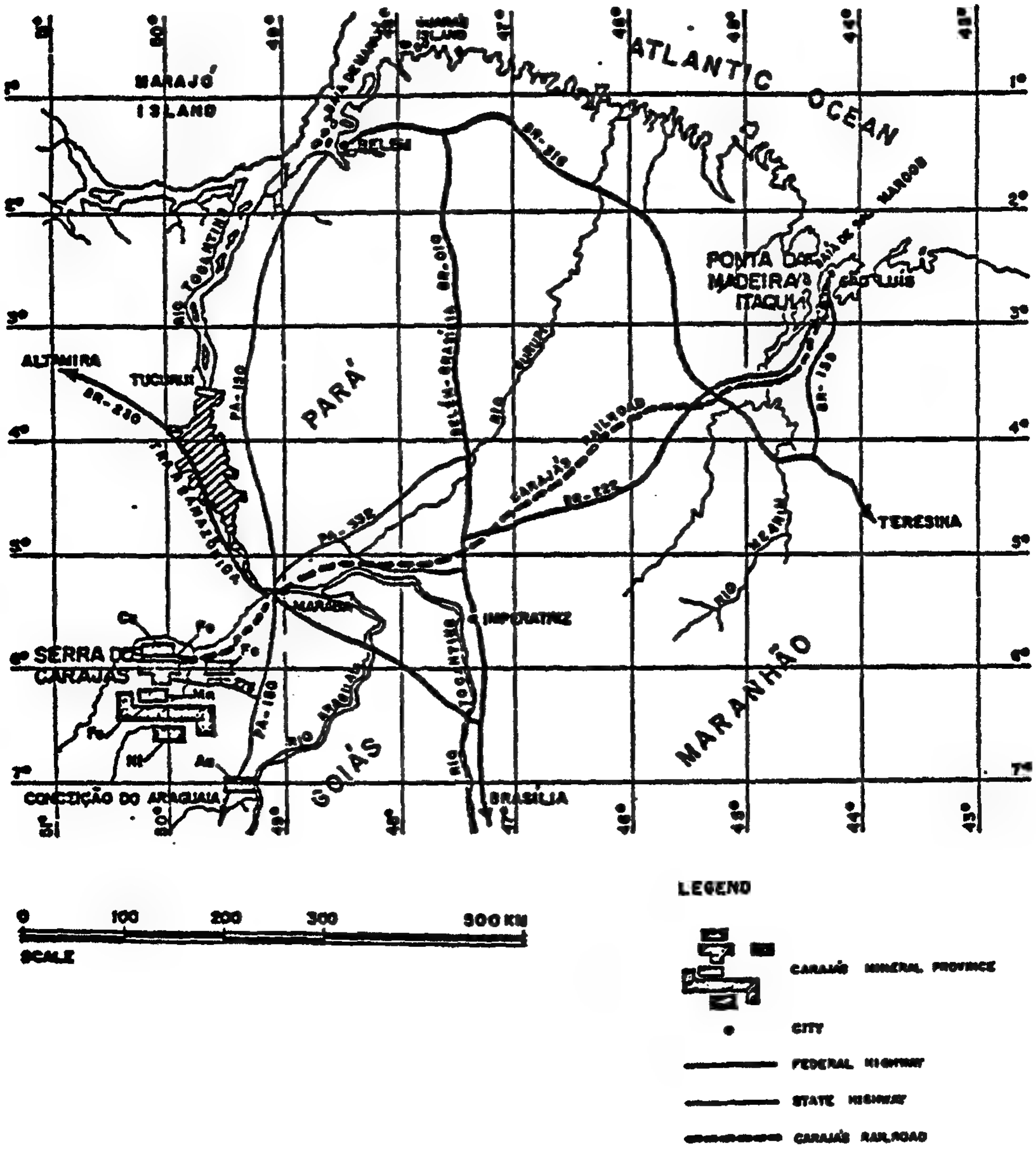
Iron ore has also been a major mineral resource in Amazonia. Large quantities and high grade deposits of this ore were found in 1967 in the Serra dos Carajás region located 550 km south of Belém and near

Marabá. These deposits are located on discontinuous ridges and plateaus that rise abruptly 200-300 m above the forest-covered valleys. Iron ore reserves in this area have been estimated to amount to more than 18 billion tons of 66 percent pure Fe. This discovery was made by geologists of the companhia Meriodional de Mineração, a United States Steel company subsidiary. From 1969 to 1972 intensive surveys were continued in the area and resulted in the discovery of deposits of other minerals: manganese, copper, bauxite, nickel, tin, and gold. These findings made the Serra dos Carajás area become Brazil's most important mineral province and one of the most rich in the world.

In 1972, US Steel (49.1 percent) and CVRD (50.9 percent) jointly formed a new corporation, Amazonia Mineração SA-AMZA (Amazonia Mining), to investigate the possibilities of future iron ore exploitation in the region. In 1975, US Steel, considering a strategic move by AMZA to shift marketing emphasis from the United States to Europe and Japan as well as the magnitude of the project envisioned, withdrew from the partnership. In 1979, CVRD bought US Steel's shares in AMZA and in early 1981 this company was merged with CVRD.

Feasability studies of the Carajás Iron Ore Project have been in development since 1972. A mineral exploration concession involving an area of 429,000 ha[20] was authorized by the Geisel administration to CVRD in September of 1974. The project has gone through several versions but its final format involves three basic components: mine, railroad, and port; all three controlled by CVRD. (See figure 51.) Construction of the project began in 1978. The first iron ore deposit

Figure 51: Location of Carajás Mineral Deposits, Tucuruí Hydroelectric Power Plant, and Transportation Network.



to be exploited (N4E) has 1,365 million tons of ore, 66.08 percent pure iron. The mine will be a conventional open pit mining operation. Due to the high grade quality of the ore, no concentration operation will be required. Beneficiation activities are only a simple reduction in size of the material extracted to sinter feed and natural pellets. Mining operations are expected to start with the production of 15 million tons per year in 1985, increasing to 25 million in the second year, and achieving the projected capacity of 35 million in 1987. Production expansion to 50-60 million is under study. The port site chosen is located in São Marcos Bay near São Luiz, Maranhão in a location called Ponta da Madeira. This site was chosen due to the limitation in water depth found near Belém. The Ponta da Madeira Port has a natural and stable 88 km seaword channel of approach, 1.6 km wide, which will permit two-way traffic for ships as large as 280,000 deadweight tons without dredging. Connecting the mine site and the port, CVRD is building a 890 km long railroad named Carajás Railroad. Through this 1.6 m wide single track railway, ore trains will travel in each direction. Each train will be composed of three 3,000 H.P. diesel electric locomotives and 160 wagons with capacity for 98 tons. Besides the mine, the railroad, and the port, the Carajás Iron Ore Project involves the construction of urban nucleus in the mine site and along the railway. The estimated total cost of the project, including financing cost, amounts to US$ 4,527 million (July 1982). Fifty percent of this amount is being used in the railroad component (US$ 1,872 million), while US$ 680 million (19.5 percent) is being used in

the mine and US$ 251 million in the port. The balance is being used to finance the townsites, project administration, and an Amerindian subproject[21]. Most of these costs are being financed by CVRD, the government, and other Brazilian sources. Foreign participation amounting to 32.9 percent of the total costs include resources from EEC, KFW of Germany, the World Bank, and four Japanese sources.

Within thirty years after the project's initiation in 1985, the Crarajás Iron Ore project is expected to generate a net cumulative foreign exchange gain of about US$ 20 billion--at 35 million tons per year production level. However, in all operations the project will generate directly only a little over 7,000 jobs of which 1,225 are to be unskilled workers.

This project has been strongly supported by the administration of General Figueiredo. Despite the economic depression that has reached Brazil in the past years, it has been one of the few governmental projects that have not been affected by cuts. In fact, the government has given very high priority for this project as well as for the Tucuruí and alumina/aluminum projects. Due to its limited impact in the regional economy and especially in terms of employment generation, it is clear that the major objective of this project is simply to generate large amounts of foreign exchange to be used to pay part of the huge foreign debt accumulated by Brazil since the first oil crises. Knowing this fact, one can understand the high priority given to these projects. However, this fact has also led the Figueiredo administration to create in 1980 the so called Greater Carajás Program

which will be discussed below (Anonymous, n.d.: 24-5; CVRD, 1981; Freitas & Smyrski-Shluger, 1983; Goodland, 1983; Santos, 1981: 74-84, 199-215; SEPLAN-PR, 1982; SUDAM, 1976a).

Mining and Hydroelectricity

Energy, as mentioned above, is one of the major inputs in the production of alumina and aluminum. Electricity in Amazonia has been dominated by thermoelectric power stations based on the consumption of imported oil. Hydroelectric energy production, not considering the Herman Kahn's Amazon River Great Lake proposal, only began to be investigated in the region in the late 1960s. The first systematic surveys of the hydroelectric potential of Amazonia were coordinated by the Comitê Coordenador de Estudos Energeticos da Amazônia-ENERAM (Coordinator Committee for Energetic Studies in Amazonia) created by Costa e Silva. The basic objective of this committee was to identify the hydroelectric potencial for the supply of energy to regional development poles, which at that time meant the major urban centers of the region[22].

With the possibilities of the construction of alumina and aluminum producing plants near Belém and São Luiz, and the hydroelectric potential found by ENERAM in the Tocantins, Médici decided to created a new government controlled enterprise to assume the responsibilities of electricity generation in the Amazon Region. The Centrais Elétricas do Norte do Brazil SA-ELETRONORTE (North of Brazil Electricity Company) was created mid-1973 as a subsidiary or

Centrais Eletricas Brasileiras SA-ELETROBRAS (Brazilian Electicity Company) which in turn is controlled by the Ministry of Mines and Energy. The outbreak of the first oil crises combined with the substantial energy needs of the bauxite processing industry implied that this industry would only be feasible with the construction of major hydroelectric power stations in Eastern Amazonia. Médici then decided for the construction of a major power station in the lower Tocantins River--the Tucuruí Hydroelectric Power Station.

The feasibility studies for the Tucuruí Station began in 1974 and by late 1975, the Geisel administration signed its construction contract. Building of the hydroelectric began in early 1976. As figure 51 above shows, it is located 300 km south of Pará on the Tocantins River. The power station is being constructed in two phases. The first, not to be completed until the end of the 1980s, will have a total of 3,960 megawatts of installed generation capacity. The second phase will add another 3,300 MW to reach 7,260 MW of capacity. This will be the world's fourth largest hydroelectric station and the largest of Brazil[23].

Tucuruí will supply electricity not only to ALBRAS, ALUNORTE, and ALUMAR, but it will also attend the demands of urban areas in eastern Amazonia--Belém, São Luiz, Marabá, Imperatriz, and other smaller cities--as well as the demands of the Iron Ore Carajás Project and other industries that may locate in the region. The bauxite processing industries are, however, the major energy consumers. The combined consumption for just ALBRRAS, ALUNORTE, and ALUMAR alone is

expected to be over 1,200 MW by the end of the 1980s while the consumption of São Luiz and Belém is expected to sum less than 400 MW. The network of long distance transmission lines connecting these consumers is also conected to the Northeast Region of Brazil which is expected to consume the surplus of Tucuruí's electricity production[24].

The Tucuruí hydroelectric power station was inaugurated by President Figueiredo on October 22, 1984 and by early 1985 the first turbine initiated electricity production. Total cost of the project has been estimated to add to US$ 4.6 billion, which is partially financed by the French.

The 243,000 ha lake--with an average depth varying between 16 and 20 m depending on the water level--that has been created, inundated 14 small towns--involving the relocation of nearly 4,000 families--parts of two Indian reserves, and tropical forest found in the area. It also inundated 40 km of the Transamazonica Highway which had to be relocated. This is the first instance of the formation of such a large lake in a tropical forest region. The Tucuruí reservoir stretches 200 km upstream from the dam, almost reaching the city of Marabá (Dias Leite, 1983: 6; Anonymous, 1983: 5; ELETRONORTE, 1978, 1983, 1984; Goodland, 1978, 1983; Magalhães, 1984).

Goodland (1978, 1983) has discussed several aspects of the environmental impact of this pioneer hydroelectric station in a tropical forest in such a scale[25]. These include human ecology aspects such as disease ecology, Amerindians; chemical, physical, and biological

effects of the reservoir (fish, weeds); transmission lines--which sum 632 km with a width of 100 m--and other aspects. In chapter VII, two basic issues related to the forest-based sector will be discussed in further details. One relates to the waste of wood resources and the other is related to watershed management. This chapter also includes discussion of two other hydroprojects currently in construction--Balbina and Samuel--and the expansion program of ELETRONORTE for hydroelectricity production in Amazonia.

V.4 The Recent Past: The Greater Carajás Program and POLONOROESTE

As mentioned above, one of the highest priorities given by the administration of General Figueiredo has been to the Carajás Iron Ore Project. But the limited regional impact of this and other expensive projects underway in the region led this administration to try a more comprehensive approach for the development of Eastern Amazonia. It was reasoned that the presence of (1) other mineral resources such as bauxite, copper, cassiterite, nickel, and gold; (2) the Carajás Iron Ore project, ALUBRAS, ALUNORTE, and ALUMAR; and (3) infrastructure of highways (Transamazonica, Belém-Brasília, and other state roads), river and ocean ports, airports, the Carajás Railroad, the Tocantins Riverway, and the Tucuruí Hydroelectric station, provided favorable conditions for the development of other economic activities in the region. Therefore, the Figueiredo administration approved the creation of the Greater Carajás Program through Decree-Law no. 1,813 of November 24, 1980.

The Greater Carajás Program

In this law, Amazonia Oriental was legally defined as the area north of parallel 8 degrees South, the Xingu River to the west, the Amazon River to the north, and the Parnaiba River to the east[1].

This area comprises 84 million ha and includes 37 percent of the area of the state of Pará, 9 percent of Goiás, and 95 percent of Maranhão—which includes areas that go beyond the limits of legal Amazonia. Figure 52 shows the area of the Greater Carajás Program.

The program calls for the development of an integrated mining-metallurgical complex based on the exploitation and processing of iron ore, bauxite, copper, casseterite, and nickel; as well as projects in infrastructure, agriculture, livestock, fisheries, wood industry, reforestation, and others considered to be of importance for the program. Estimates of the resources needed to implement the program amount to US$ 60 billion, transforming it in the most ambitious plan ever designed for the region. But, unlike the Carajás Iron Ore Project, the necessary projects and funds to undertake the program are expected to come mainly from the private sector, both domestic and foreign. The government would restrict its activities to the provision of the necessary infrastructure of collective nature, and to the granting of special financial and fiscal incentives to attract private investment.

To coordinate, promote, and execute the necessary measures in the program, the government created an Interministerial Council linked directly to the Planning Secretariat of the Presidency. Among other measures, this council created six industrial zones in Oriental Amazonia: Barcarena, Marabá, Serra dos Carajás, and Tucuruí in Pará; and Imperatriz and São Luiz in Maranhão (Anonymous, n.d.; Mahar, 1983: 321-2; Moran, 1983b: 176; SEPLAN-PR, 1982, 1984).

Figure 52: Map Showing the Area of the Greater Carajás Program.

Although recent information has not been available, it is likely that, despite the favorable terms given to attract the private sector to the region, the depression that has affected Brazil since the early 1980s has limited the creation of any new major project. On the other hand, the increased activities in the region have apparently attracted more immigrants to the area, increased demand for land, and consequently, price rises have generated further gains to land speculators and has intensified conflicts over land control. One example of this is the increased posseiro activities that have occurred along the Carajás Railroad--according to the literature, an expected effect of the opening of new access in tropical forest areas.

New Institutional Arrangement for Land Affairs

Resolving the land conflict problems found in parts of Amazonia has become one of the priorities of the Figueiredo administration. To deal with this situation in Eastern Amazonia, the government created through Decree-Law no. 1,767[22] of February 1, 1980, the <u>Grupo Executivo das Terras do Araguaia/Tocantins</u>-GETAT (Executive Group for the Araguaia/Tocantins Lands). GETAT was initially directly linked not to the Ministry of Agriculture like INCRA, but rather to the more powerful National Security Council which, in turn, is under the chief of the Military Cabinet. Its objectives are to coordinate, promote, and execute the necessary measures to regulate the land tenure situation of Southeast Pará (70 percent of GETAT's total area of action), North Goiás (20 percent), and West Maranhão (10 percent). The

area of responsibility of the group, one of the most intense land conflict areas in the region, comprises 45 million ha and is illustrated in figure 53. This brand new organization was given the same responsibilities of INCRA in this area where the institute would not act anymore. These responsibilities included also the promotion of Colonization.

GETAT began its activities in October, 1980 and quickly concentrated on the areas of social tension due to land disputes. By the end of 1982, it had put together an impressive infrastructure which included 15 executive units with almost 800 employees--of which nearly 20 percent had university level training. To its credit during this period, GETAT has (1) the identification and addition to the nation's patrimony of over 3.5 million ha of terras devolutas; (2) the appropriation of almost 340 thousand ha from private oweners and terra devoluta status to benefit 5,000 families; (3) the demarcation of 27,268 land properties totalling nearly 3.5 million ha; (4) the granting of over 25 thousand land titles; and (5) the settlement of 10,492 families.

The high priority given by the Figueiredo administration to land problems was not restricted to the creation of GETAT. Besides the creation of special legislation to deal basically with possession claims in private lands, the so called usucapião especial,[3] the government gave extra support to INCRA for it to step up its activities. According to INCRA's President, Paulo Yokota (1981: 24-8), the government's actions would concentrate on (1) the identification of

Figure 53: Map Showing the Location of the Area Under the Control of GETAT.

Source: Adapted from GETAT, 1983.

terras devolutas; (2) the sale of public land to rural workers and to private colonization companies; (3) the disappropriation of land areas under conflict so as to solve them; (4) the titling of land properties; and (5) the undertaking of official colonization projects.

The actions of the Figueiredo administration with respect to land problems, culminated with the creation of the Programa Nacional de Política Fundiária-PNPF (National Program for Land Policy) and the Ministério Extraordinário para Assuntos Fundiários*-MEAF (Extraordinary Ministry for Land Affairs) specially created to plan, coordinate, and execute it. The objectives of the PNPF are to unify the implementation of the government's land policy, and to intensify the execution of the Estatuto da terra in order to assure the compliance of the constitutional principle of the social function of the land property. MEAF would pursue that through land tenure regulation, land survey, zoning, and taxation, land destribution, colonization, and the promotion of rural development. Institutionally, GETAT was put under the new ministry while INCRA is now coordinated by MEAF--although the institute is still administratively linked to the Ministry of Agriculture. The great support of the presidency to this new ministry was explicitly put in the legislation by which the Planning Ministry should give high priority to the MEAF's requests and was also demonstrated by the nomination of the chief of the Military Cabinet (a ministerial position) as MEAF's minister who has also powers over the National Security Council.

The Figueiredo administration has as a goal to distribute

around 1.2 million new land titles in all Brazil, which corresponds roughly to 15 million ha. In accordance with the historical tradition of increasing agricultural production through the expansion of the agricultural frontier, this area corresponds to an increase of 30 percent of the current cultivated area in the country[a]. Most of this new land is located in Amazonia which represents an increased pressure over the forest resources of the region and a doubtful growth in agricultural production (GETAT, 1983; Mueller, 1980: 141; Planejamento e Desenvolvimento, 1982a, 1982b; Poelhekker, 1982; Valente, 1983; Veja, 1982; Yokota, 1981).

Migration to Rondonia

Eastern Amazonia was not the only area in the region suffering substantial land conflict pressures. Another area in Amazonia with a similar situation was the federal territory of Rondonia into which literally thousands of persons have spontaneously migrated since the early 1970s.

As mentioned above, the most recent human occupation of Rondonia began in the late 1950s with the beginning of casseterite mining operations by garimpeiros. This movement was facilitated with the completion in 1960 of a precarious road connection between Cuiaba, in the state of Mato Grosso, and Porto Velho, Rondonia's capital. By late 1960s, this road had been substantially improved though during the height of the rainy season it usually becames almost impassable.

A little before the Medicí administration started to develop the

Transamazonica Highway agricultural colonization scheme, INCRA, beginning in 1970, was involved in developing the first integrated colonization project in Legal Amazonia, the PIC Ouro Preto in Rondonia. This project was well located in one of the relatively good natural fertility Alfisol patches that exist in the territory. INCRA gave 100 ha lots (and some of 200 ha) to families and provided some of the same facilities later also given in the Transamazonica projects, as discussed above (Arruda, 1976: 34-9; Mueller, 1980; World Bank, 1981: 14).

Since the creation of PIC Ouro Preto, a growing wave of migrants have come to Rondonia in search of land. The total population of the territory which in the 1960s grew at an annual average rate of 4.8 percent reaching 111,084 inhabitants in 1970, jumped to 490,153 in 1980 which implies in a yearly growth of 16.0 percent in the 1970s. The rural population of Rondonia in 1970s grew at an annual average rate of 17.6 percent while the urban growth was 14.6 percent. (See appendix 9.) Most of this growth was the result of migration as table 13 illustrates. Most of these migrants were young, male, from an agricultural background, and had resided in Paraná or Moto Grosso states[6].

PIC Ouro Preto and PIC Sidney Girão,[7] created in 1972, were the only two of the seven colonization projects created in Rondonia within the concept of a controlled settlement policy. The other five created until 1975 that followed these two initial ones were developed as remedial measures due to pressures and land conflicts resulting from

Table 13: Number of Persons Processed at Rondonia Migrant Orientation Center (CETREMI), 1976-1980.

Year	Persons Older than 5 Years Old*
1976	17,126
1977	6,316**
1978	14,755
1979	44,278
1980	57,572

* Considered underestimation since counting was done only during normal working hours (Martine, 1980: 89).

** According to Mueller (1980: 149), this reduction was due to unussually wet rainy season.

Source: World Bank, 1981: 16.

the increasingly massive migration. (See table 14.) This apparently fast response by INCRA has been, in operational terms, uneven and slow. Already by 1976, most colonization projects were congested and the number of migrant families awaiting to be settled was substantial. Meanwhile, these families were forced to find other alternatives such as (1) the invasion of Indian areas, INCRA's non-allocated plots, and lands outside colonization projects including through the extension of feeder roads at the end of INCRA's project limits; and (2) the participation in sharecropping arrangements in plots of relatives, friends, and other settlers. These families who had not managed to obtain a piece of land to stay, had consequently joined the marginal population of newly erected urban areas. By mid 1977, the number of migrant families estimated to be in such a situation had reached 30,000. INCRA's performance in titling land plots was particularly slow. Until 1978 the institute had issued only 6,929 titles of a target of 23,916 (Arruda, 1976; INCRA, 1984; Martine, 1980: 89-90; Mueller, 1980: 149-50; World Bank, 1981: 51-2).

There are two main groups of factors that have been listed to explain the increasing wave of migrants to Rondonia: push factors in the origin areas and pull factors in the territory. On the one hand, among the push factors are those which have reduced rural employment opportunities in the origin regions due to (1) agricultural mechanization, (2) expansion of large commercial farming producing export crops like soybeans, (3) substitution of agricultural production by large scalle cattle ranching, (4) climatic problems such as frost

Table 14: INCRA's Official Colonization Projects in Rondonia (as of 1983).

Projects	PICs(a)					PADs(a)		Total
	Ouro Preto	Sidney Girão	Ji-Paraná	P.A. Ribeiro	Pe. A. Rohn	Burareiro	Mal. Dutra	
Implantation Year	1970	1972	1972	1974	1975	1975	1975	—
Total Area (ha)	512,585	60,000	486,137	293,580	407,219	304,925	494,691	2,559,137
Number of Settled Families	5,162	638	5,756	3,689	3,106	1,540	4,767	24,658
Titles issued by INCRA(b)	4,060	569	3,444	2,300	1,983	616	1,421	14,393
Converted Area (ha)								
.Permanent(c) Crops	133,073	10,843	164,451	59,709	84,516	64,782	38,789	556,163
.Annual(d) Crops	289,295	54,055	343,503	153,125	n.a.	105,142	59,160	1,004,280
.Pasture(e)	69,814	4,887	40,000	31,920	22,580	22,680	17,325	209,206
INCRA's Total(f) Investment	16,402	4,810	8,613	10,528	7,575	3,146	5,708	56,782

(a) PIC: Integrated Colonization Project and PAD: Directed Settlement Project; (b) Through July, 1980; (c) Mostly coffee, banana, cacau, rubber tree; (d) Mostly rice, corn, beans, manioc; (e) Total cattle heard estimated at 195,290; (f) 1982 US$ 1,000. The total amount of resources available to INCRA was in fact US$ 73,794,000, but the balance was not invested.

Source: Adapted and calculated from INCRA, 1984; World Bank, 1981: 51.

affecting coffee production in Paraná and São Paulo and droughts in the Northeast; and (5) the highly concentrated land ownership structure and the difficulties faced by small farmers to have access to land. Another important push factor is the sale of family owned small holdings (minifundio) whose value has increased due mostly to the demand for the formation of large export oriented commercial farms. Those minifundios have been created by the excessive fragmentation of the original land properties through inheritance in areas such as northern Paraná and southern Mato Grosso. The lack of employment opportunities in urban centers--which have resulted from the failure to generate sufficient number of jobs of the industrial approach of past development policies--for the urban poor and the increased number of rural-urban migrants also has pushed many of them to migrate to frontier areas.

On the other hand, a combination of other factors has made Rondonia an attractive region to potential migrants. First there was the improvements completed in 1969 on the access road connecting Cuiaba to Porto Velho. In addition, the fact that the first of INCRA's official colonization projects in the territory (PIC Ouro Preto) was properly located in a patch of relatively fertile soils, has led to the rapid spread--through family and friends' reports and other means--of rumors about the existence in Rondonia of inexpensive or "free" land with high quality soils. The very implantation of INCRA's colonization projects also has probably contributed to reinforce the territory's attractiveness to migrants (Bunker, 1982: 589; Furley, 1980: 42; Goodland, 1983: 8-10; Martins, 1980; Mueller, 1979: 56, 86, 1980: 142;

Velho, 1984; World Bank, 1981: 14-15).

Not only migrant families were attracted to Rondonia. Grileiros, private companies, and others came to the area for land speculation reasons and they appropriate land illegally and sold it to unwary settlers. The activities of these speculators some times included the promotion of migration.

Faced with the increasing number of migrants, the Geisel administration tried to discourage these flows using both persuasion and authority. Persuasion included a propaganda campaign with the distribution in various origin areas of pamphlets about the non-availability of unoccupied land with good soils for distribution and the potential risks and hardships involved in migrating to Rondonia. It is also reported that authority instruments were used through the highway patrol which was forcing the return of trucks carrying migrants to Rondonia. Needless to say, these approaches were largely unsuccessful.

The Figueiredo administration is attempting other means to deal with the growing numbers of migrants to Rondonia. Reflecting INCRA's national office new emphasis on titling, the institute has dramatically increased the number of land titles given to rural families. In 1979, INCRA issued 2,814 titles while just in the first 6 months of 1980 another 4,650 titles have been issue. Feeder roads have also been the subject of INCRA's concerns and with, the help of the rural communities, progress has been made in improving and constructing them (Martine, 1980: 91; Mueller, 1980; World Bank, 1981: 51-3; Yokota,

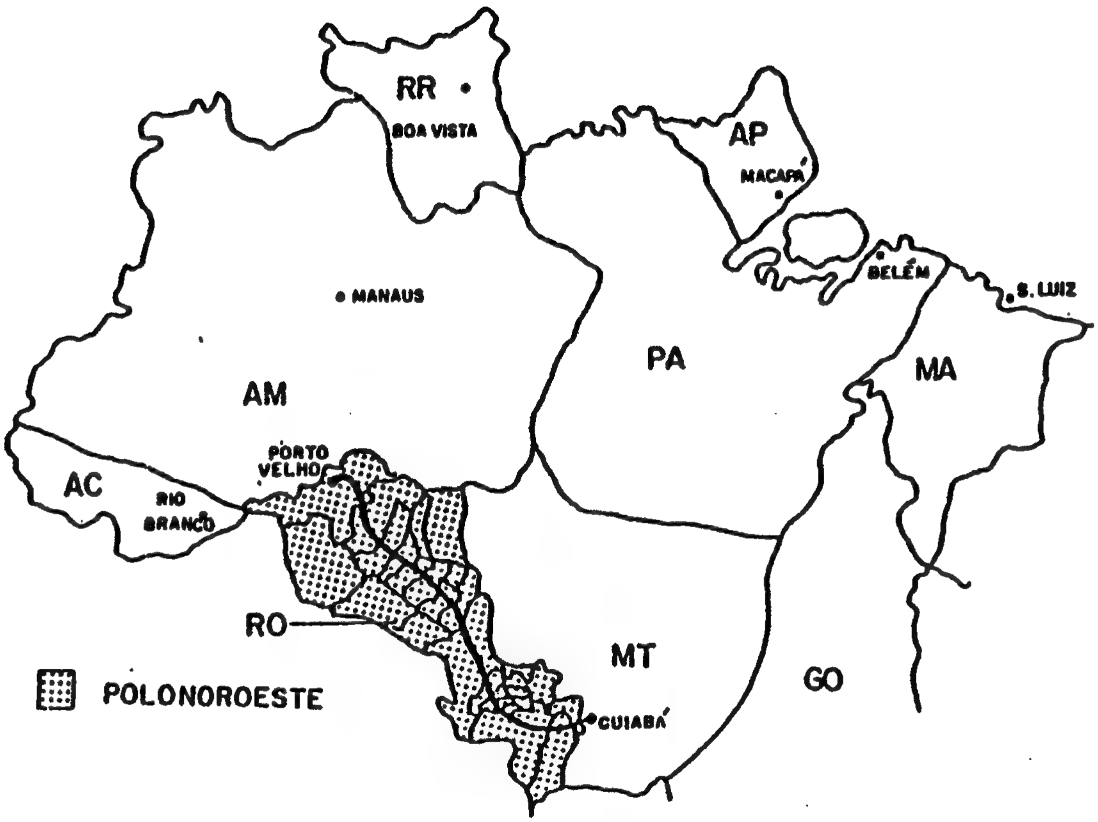
1981: 11-2).

POLONOROESTE

Figueiredo granted the condition of statehood to Rondonia on December 21, 1981,* and approved the established of the Programa Integrado de Desenvolvimento do Noroeste do Brasil-POLONOROESTE (Northwest Brazil Integrated Development Program). This program, also established in 1981, was designed to help to bring order to the large migratory flow to the Northwest region. Officially, the Northwest region is defined as the area of influence of the 1,442 km Cuiaba-Porto Velho Highway--BR-364. It encompasses all of the state of Rondonia and the western part of Mato Grosso as shown in figure 54. This represents a total area of 41 million ha--24.3 million ha in Rondonia.

POLONOROESTE is costing the Brazilian tax payers, in the 1981-1986 period, some US$ 1,228 million equivalent (at August 1984 official exchange rate) of which the World Bank has financed nearly a third part and the balance has been put by government budget allocations which includes the use of PIN funds. POLONOROESTE's estimated budget for the period 1981-1986 is shown in table 15. The bulk of these resources (59 percent) were used to reconstruct and pave BR-364, improve and build a secondary and feeder road network, and to strengthen Rondonia's Roads Department. Another 33.6 percent of the POLONORDESTE funds are being used for the implantation of new settlement projects,* consolidation of existing ones, and the execution of land tenure regulation services.

Figure 54: Map Showing the Northwest Region of Brazil.



Source: Modified from Pina (1983).

Table 15: POLONOROESTE Estimated Budget, 1981-1986 (In Millions of August 1984 Cruzeiros).

Component	Cr$	Percent of the Total
Transport	1,444	59.0
.BR 364 Paving	1,255	51.3
.Feeder Roads	96	3.9
.Strenghtening of DER Rondonia	93	3.8
Agricultural Development	822	33.6
.PDRI Rondonia	326	13.3
.PDRI Mato Grosso	161	6.6
.Land Tenure Services	24	1.1
.Settlement of New Areas	311	12.7
Health	49	2.0
.Malaria Control	41	1.7
.Health Research	8	0.3
Environmental Protection	51	2.1
.Forest Control & Protection	23	0.9
.Ecological Stations	6	0.2
.Ecological Research	22	0.9
Amerindian Affairs	51	2.1
Administration	29	1.2
TOTAL	2,446	100.0

.PDRI: Integrated Rural Development Project.
.DER: State Road Department.

Source: Adapted from Pécora (1984: 54).

The Project also included funds for (1) malaria control and health research; (2) minimization of the negative effects of POLONOROESTE on the Northwest's estimated 8,000 Indian population, including demarcation of Indian reserves, provision of health and education services, and agricultural production assistance; and (3) environmental protection which includes the strengthening of IBDF's enforcement capability in the region, the provision of infrastructure for the Pacaás Novos National Park, Biological Reserves, and Ecological Stations (under the responsibility of SEMA), and the identification of National forests[10].

Besides item (3) above, POLONOROESTE is supporting a new approach to deal with the requirements of the Forest Code in Amazonia. In the new settlement projects, INCRA is putting the 50 percent conservation land in blocks rather than on individual plots. This approach is ecologically advantageous, facilitates the monitoring and control of these areas and, most importantly, allows these areas to be collectively managed to generate additional income to the settlers. INCRA also intended to promote the increased use of the timber that has to be felled during land clearing operations as a source of income for the colonists. During the agriculture crop implantation phase, settlers generally have no other income source from the land. Unfortunately no empirical information has been available for analysis of these new approaches by INCRA.

But the contribution of the forest-based sector to the development of the Northwest region, as programmed by the POLONOROESTE,

is too small; especially in the light of its integrated development approach. Currently, the sector's participation in the region's economy is already much larger than this limited role envisioned. For instance, since much of the land in the colonization projects was under forest cover, wood production in Rondonia has been positively correlated with the conversion activities. However, loggers have usually extracted only the most valuable species--mostly Cerejeira (Malpighia spp) and Mogno (Swietenia spp)--due to the high costs of production and transport, while the remaining timber is usually burned or allowed to rot. Despite this waste of resources, wood has been extensively used in the region, especially as house construction material, post for fencing and as fuel. Timber exports from Rondonia have also increased substantially with the increased land clearance activities. Official statistics indicate that in 1974 the territory exported 22,500 m^3 of timber and in 1978 these exports had grown to 90,000 m^3. Nearly half of all industrial establishments registered by the territorial secretariat of planning in 1978 were sawmills and wooden furniture making operations. Rubber processing plants are also present in the region (PECORA, 1984; PINA, 1983: 18-48; Planejamento e Desenvolvimento, 1984: 39, 41; Teixeira, 1982; World Bank, 1981).

In a survey done for IBDF in 1981 (IBDF, 1983b), it was found that Rondonia had 387 sawmills and 16 veener plants. These plants consumed an estimated 1,43 million m^3 of roundwood to produce 804,000 m^3 of wood products of which 69,000 m^3 were veneer. Besides Mogno and Cerejeira--which comprised nearly two-thirds of the

log consumption—another 22 different species have been used in the state, mostly for local consumption. These plants employed nearly 8,000 persons in the territory that year, 44 percent of which received two or more minimum wage salaries. Firms producing less than 5,000 m^3 per year employed almost 80 percent of these workers. Veneer plants—producing a more elaborated output—employed 2.7 times more workers per output unit than the average sawmill. Wood was used also as fuel for over 50 percent of these firms.

This survey also found that the local market consumed only 20 percent of 1981's sawtimber and veneer production. Most of the production was sent out of the state. The Cuiaba-Porto Velho road has been heavily used for exporting wood products since. Most of RONDONIA's wood products was sent to São Paulo (30.3 percent), Paraná (14.7 percent) Rio de Janeiro and Rio Grande Sul. Sixteen percent of the states production was exported, but, not only through the northern ports of Manaus, Belém, and others, but also through the Southern ports of Santos in São Paulo and Paranaguá in Paraná. Giving the current contribution of the forest-based sector to Northwest economy, it is disappointing the low role attributed to the sector in the context of POLONOROESTE.

On September 13, 1984, the Cuiaba-Porto Velho road—which was officially named Marshall Rondon Highway as a tribute to that pioneer—was inaugurated by President Figueiredo who called it the most important road project of his administration. This road is expected to benefit the region's inhabitants by lowering input costs as well as

reducing the costs of transportation of the region's production. Wood products industries are likely to benefit from those improvements since most of log production and output commercialization is done by road which up to recently used to decrease substantially during the wet season. However, so far log production has been only a small by-product of the conversion of forest land for agriculture production. Very little has yet been done to develop adequate technologies for the sustained management of these forests or to design appropriate institutional arrangements for a possible implementation of such technologies.

Meanwhile, the now paved Cuiaba-Porto Velho road is also facilitating arrival of new migrants. The good transportation means combined with the extra push factor given by the economic depression that reached Brazil in the early 1980s—which was not foreseen by POLONORDESTE's planners—and with the consequents decreased in urban employment opportunities, brought additional incentives for the move. In fact, even before the inauguration of BR 364 and just during the first 6 months of 1984, some 80,000 migrants had used the road on their way to Rondonia. It has been estimated that, with the completion of the road the number of people arriving in Rondonia each year may reach 300,000.

Despite INCRA's increased emphasis on land titling and the creation of new agricultural colonization projects, it is likely that such level of migration will only aggravated the land conflict problems already existents in the region.

The chances for INCRA to satisfactorily solve such conflicts through further distribution of land and the promotion of agricultural colonization are not promising. Despite the belief to the contrary of some government decision-makers, most of the relatively fertile soil patches--comprising almost 10 percent of the state--existent in Rondonia have already been distributed to or taken by migrants. Therefore, new colonization activities are having to be located in poorer soils. (See table 16.) Although INCRA has been promoting the increased use of permanent crops in the region--mostly coffee, cacao, and rubber-tree--instead of annual crops as the basis of income generation for the settlers, it is uncertain the long term sustainability of these activities.

Given this increased immigration to Rondonia and its limited capacity to absorb the expected number of persons arriving, and as has happened in the recently colonized southern Mato Grosso and northwestern Paraná, a migratory flow to the neighboring state of Acre may be foreseen. The likelyhood of this possibility is further increased by the recent announcement by the Figueiredo administration--as one of his last decisions--the continuation of the paving of BR 364 until Acre's capital, Rio Branco, and Cruzeiro do Sul (see figure -- above) on the northwestern extreme of that state. For a total cost of US$ 146.7 million--of which US$ 58 million is being financed by the Inter-American Development Bank (IDB)--the 502-km section of the highway will increase accessibility of Acre to migrants. Acre, in fact, has already some land problems with the expulsion of

Table 16: Land Capability Classification in the Northwest Region.

Class	Rondonia Million ha	%	Mato Grosso Million ha	%	Region Million ha	%
Good	2.412	9.9	0.519	3.1	2.931	7.1
Moderate	14.582	60.0	3.606	21.6	18.189	44.4
Marginal	1.798	7.4	6.883	38.2	8.182	20.0
Unsuitable	5.513	22.7	6.187	37.1	11.700	28.5
TOTAL	24.305	100.0	16.695	100.0	41.000	100.0

"Good": Soils dominantly terra roxa or eutrophic podsols, frequently with eutrophic lithosols in patches. Suitable for annual or perennial crops on a sustained basis;

"Moderate": Soils dystrophic, deep latosols with clayey or loamey textures. Normally require liming and fertilizers for sustained agricultural production;

"Marginal": Soils dystrophic, sandy or concretionary, always requiring liming and fertilizers in agriculture, texturally unsatisfactory for fertilizers;

"Unsuitable": Unsuitable for known land uses.

Source: Adapted from World Bank, 1981: 58.

rubber and other forest products gatherers by ranchers and other land speculators. INCRA has also a Directed Settlement Project (PAD) to attend the demand in the state for agriculture colonization land by migrants. The paving of this section of BR 364 will improve accessibility to Acre's forests as well as result in larger migration to the state as Rondonia's capacity to absorb migrants further decrease (Carvalho et al., 1979: 241; Fearnside, 1984: 49; Furley, 1980: 42; IDB News, 1985: 10; Kuck, 1984; Pecora, 1984: 48; R. P. Pina cited by Planejamento e Desenvolvimento, 1984: 40-1; Ulman, 1984).

If agriculture production on the dominant poorer soils turn out to be a failure in coming years, those settlers who choose to stay in these areas are likely to face increased levels of hardship. Under such a situation the government may be forced to further subsidize these families to avoid the possibility that, as Ulman (1984) puts it, "the great move west could turn to tragedy".

IBDF's Actions

The increased pressures on Amazonian tropical forests first brought by the cattle raising industry and then by the agriculture colonization of growing numbers of migrants has met a slow response from IBDF, as further discussed in part III. The institute has initiated a program to monitor the deforestation in the region, but it has been unable to intervene in the deforestation process. Also in part III is a discussion of an IBDF program initiated by the Figueiredo administration for the creation of new preservation areas of Amazonian

ecosystems. IBDF's actions in Amazonia during the Figueiredo administration have not been, however, limited to the continuation of the deforestation surveys and the creation of new conservation units. Although tha institute seems to have been awaiting for the approval of the new forest policy for the region—which it expected to happen at any day for nearly six years—it did try to initiate some alternatives to explore the possibilities of increasing the participation of the forest-based sector to the region's development. The two most important (as far as IBDF is concern) attempts that the organization has been trying are (1) the tropical forest management of the Tapajós National Forest, and (2) the improvement of wood products commercialization.

As mentioned above, the Tapajós National Forest was created in early 1974 by the Medicí administration and became Amazonia's second national forest. It is located in the state of Pará on the right bank of the Tapajós River some 50 km south of its mouth where the city of Santarém is found. The east boundary of the 531,000 ha[11] national forest is the Cuiaba-Santarém road.

Since the creation of this national forest, IBDF has promoted several forest inventories and, in cooperation with FAO, EMBRAPA, and SUDAM, has supported silvicultural, wood technology and forest exploitation research in the area[12]. From late 1977 to May 1978, an intensive effort was undertaken by IBDF and FAO in order to appraise the opportunities and problems of tropical forest management combined with industrial activities as a basis for forestry and regional development in Amazonia. The Technical Cooperative Program's

objectives were to advise IBDF about these opportunities and problems, to provide in service training to Brazilians, and to undertake a group-training tour to Europe and Asia for selected Brazilians officials and entrepreneurs. A team of 16 international experts and 28 Brazilians counterparts from IBDF and other organizations participated in the program.

According to FAO's terminal report for the Brazilian government on the results of the program

> The prospects for forest-based development of the Amazon depend on answers to two fundamental questions:
>
> (a) Could the forest be managed as a permanent timber prodution system without destroying its basic natural tropical forest character or seriously impairing its environmental role and values?
>
> (b) Would a forest products industry based on the wood supply from forests managed in such a way be a reasonably economic and self-reliant proposition?
>
> The mission's considered opinion in both of these respects is in the affirmative with respect to the Tapajós National Forest and other similar areas in the Amazon. This is provided, however, certain environmental safeguards, adequate management and control, and concomitant data generation, monitoring and review are undertaken in the forest, and provided appropriate institutional support for the success of the project is made available (FAO, 1978).

This conclusion was reached on a pre-feasibility study of a combined forest management and wood industry project. This study assumed that only 122,000 ha of the National forest would be available initially for wood production. An average of 5,000 ha would be harvested every year for the production of 150,000 m^3 of selected commercial species (30 at the time) logs (minimum girth of 45 cm) in a

22 year cycle. The area harvested would then receive silvicultural treatments (enrichment planting and replanting) to assure perpetual wood supply for a 58,000 m^3 $year^{-1}$ sawmill and a 9,000 m^3 $year^{-1}$ plywood mill assumed to be located in Santarem. Eighty percent of theses wood products would be sold in the domestic market while the rest would be exported. The pre-feasibility financial appraisal of this project, which would create an estimated an estimated 800 direct jobs, indicated that it could yield an internal rate of return of 53 percent before taxes. "If all odds are loaded against the project...the internal rate of return drops to a still satisfactory level of 19.5%"(FAO, 1978:8).

After the publication of these optimistic results, IBDF again in cooperation with FAO and EMBRAPA, began the development of a management plan for the Tapajós National Forest. The plan, completed in 1980, kept the program's goal of producing 150,000 m^3 of commercial timber per annum but (1) reduced the harvested area per year to an average of 4,000 ha; (2) increased the total forest management area to 136,000 ha; and (3) increased the rotation of 42,000 ha to 70 years because these forests were to be naturally regenerated and the rotation of the other 94,000 ha[13] to 35 years because these areas were to be enriched by planting of selected commercial species.

Despite the completion of the management plan, it seems that institutional constraints have limited IBDF's capability to carry it out. Furthermore, the prospects that a new forest policy for Amazonia--which would address some of these constraints--could be

approved at any day led IBDF to pursue a very modest program of investment in the area while it fruitlessly awaited for president Figueiredo's final decision on the matter. All that the institute has been able to do in the meanwhile was to prepare a 1,000 ha-forest track for commercial harvesting--including a census of commercial logs and road building--through a yet undefined institutional arrangement (FAO, 1978; FAO/IBDF, 1980; IBDF, 1982c; IBDF/FUPEF, 1983).

Another action taken by IBDF during the Figueiredo administration was to start a program for improving commercialization of sawtimber in Amazonia. The Programa de Entrepostos Madeireiros para a Exportação-PROMAEX (Program of Entrepots for Wood Products Export) was officially started in 1982, but its roots can be traced to suggestions made by SUDAM in the I Amazon Development Plan (PDAM I) discussed above (SUDAM, 1971: 20). The program was conceived based on the fact that small and medium size sawmills represent 92 percent of the total number of sawmills and 70 percent of the sawtimber produced in Amazonia. But, due to inefficiencies resulting from inadequate technology, capital, and humam resources associated to those small operations, these producers have been largely left out of the international markets. PROMAEX was designed to help those producers by the creation of a network of commercial entrepots distributed throughout Amazonia. These entrepots are expected to provide various services to these producers, including: sawtimber storage, wood products classification,[14] sawtimber reprocessing to assure common quality products, wood preservation treatment, product packing,

transportation from entrepot to port, ship contracting and others. The entrepots would also promote the realization of training cources for sawmill managers, and for products classification and packing workers. Entrepots would gather and distribute information on market conditions and promote new wood species in foreign markets. Importers are also expected to benefit from this network since they could place their orders in a single place and have a certain assurance of good guality sawtimber at adequate quantity even in long term contracts.

The program started with the proposition for the creation of 5 entrepots to be located in the following places: Porto Velho (Rondonia); Manaus (Amazonas); Santarém and Marajó Island (Pará); and Boa Vista (Roraima). IBDF officials expected that from 1982 to 1990, PROMAEX would increase sawtimber commercialization from an accumulated total of 77.6 to 85.3 million m^3, which would also result in the creation of 13,000 new direct jobs in the region.

PROMAEX was programmed to start with the creation of the entrepots of Santarém and Porto Velho in 1982 and 1983. The Santarém entrepot was inaugurated only in late 1984 and the others, including the Porto Velho one, have shown little progress. The operation of the Santarém entrepot is also expected to benefit the possible forest activities to take place in the Tapajós National Forest (IBDF, 1982l; Sinal Verde, 1984b). There are also some institutional problems with PROMAEX such as the way by which price for wood products will be arrived at--which can be empirically checked once operations in Santarém start.

Dispite the modest start of this program, PROMAEX combined with the prospects for forest management in the Tapajós National Forest and the approval of IBDF's Normative Directive 302-P--discussed above--do put IBDF in a better track towards the increased participation of the forest-based sector to Amazonia's development. With the end of the two decades of military rule of Brazil in 1985 there will probably appear opportunities that could be taken advantage of by a new IBDF leadership to improve the sector's contribution to the country's development.

Notes on Chapter V.

Section V.1.

1. At least 8 major agrarian laws had been proposed in congress during the years before the revolution but most of them were defeated or cancelled. In fact, the agrarian reform issue was so much alive during these years that many believe that it was one of the major causes of the revolution itself (Cehelsky, 1972: 241; Cehelsky, 1979; Pereira, 1984: 99).

2. Expropriation of private land properties can also be made to promote rational land exploitation, to create flora and fauna protection areas, among others (Art. 18).

3. Land and colonization administration has been part of the Minister of Agriculture since 1934 when Vargas created the Colonization, Reforestation and Irrigation Service. In 1938, Vargas created the Land and Colonization Division in the Ministry of Agriculture in order to provide solution to land conflicts in South, Southeast, and Northeast regions of Brazil through the promotion of systematic colonization in frontier areas. Although this policy has been used several times in Amazonia since Vargas first introduced it; its impact in Amazonia was very limited (other frontier areas such as Paraná were available). In 1954, Vargas once again created a new organization concerned with land and colonization matters. This time it was the National Institute for Colonization and Immigration which also had very little action in Amazonia. Vargas' pupil, President Goulard created the Rural Policy Superintendency (SUPRA) in 1962 but it was short lived (Cardoso & Muller, 1977: 119-21; Tavares et al., 1972).

4. The ITR is progressive on "unproductive" land and was conceptualized as a means to increase the cost to latifundio owners of keeping their land with no use. Taxers on land in Brazil before the revolution were by and large nonexistent (Cehelsky, 1979: 214).

5. Law 6,383 of December 12, 1976 in its article 29, changes this aspect of the <u>Estatuto da Terra</u> by granting the right to posseirc of legitimation of that land up to 100 ha continuous provided that the settler is not already a land owner in addition to the <u>cultura efetiva e morado habitual</u> condition. The posseiro then gets an occupation license (licença de ocupação) for 4 years. After this period in which the posseiro is supposed to work and live in that land, he will receive a final property title. Posseiros can use their licence de ocupação as a guarantee towards rural credit. Law no. 4,947 of April 6, 1966, interestingly enough, defines the posseiro who has not lived in an area for more than one year in the terra devoluta, as illegal invadors

subject from 6 months to 3 years of imprisonment for this unlawful action.

6. Rural module is a standard unit of farm size and is defined as that minimum land size which will absorb all the labor of a typical rural family, assuring its subsistence and social-economic progress. A rural module varies from region to region and in Amazonia it usually means 100 ha.

7. These facts have been obtained in personal communication with INCRA officials in Altamira-PA during my field trip to Amazonia in the first quarter of 1984. For a complete schedule of this trip see appendix 3. See also Fearnside (1983: 143 and 1984: 56) for related observations. The Rural Land Tax (ITR) has also had a built in stimuli for the removal of the forest cover of private land and its conversion to low capital/area land uses such as cattle raising (Fowaraker, 1981: 36). Its effect may have not been as important in practice as the direito de posse because ITR has not been implemented as intended resulting in a far less progressive tax in addition to being a very small tax (World Bank, 1982: 69-71; 118-9).

8. Laws no. 5,173 and 5,174 with Law no. 5,122 (which created BASA) were all regulamented by Decree no. 60,079 on January 16, 1967. The basic legislation related to SUDAM is available in SUDAM (1982).

9. Law 5,173 kept the same concept of Legal Amazonia as defined by previous laws.

10. The post-1964 revolution brought a new policy of acceptance of foreign investment in the country. Through a constitutional amendment approved in December, 1965, foreign capital became also eligible for tax credit funds which before were only available to firms with 100 percent national capital. Nationalists, however, have protested the foreign involvement in Amazonian development but very selectively and sporadically (Galey, 1977: 192; Mahar, 1979: 92; Pompermayer, 1979: 172-3).

11. In practical terms this item has resulted only in a greater research investment by SUDAM in the CTM program. Since forest-based activities were to be replaced by "more profitable" agriculture and cattle raising activities, Pompermayer (1979: 174) has argued that this provision "(discouraged) the extractive activities upon which regional elites had based their political power in the past."

12. SUDAM was actually created under MECOR which in February of 1967 was transformed in the new Ministry of the Interior.

13. This deadline has been extended by all the revolutionary governments after Castelo Branco (except by the Medicí administration) by shifting its end to the next government. Thus, in 1969 Decree-Law

no. 756 extended this deadline to 1974 and established that it would be valid for 10-15 years. In 1977 Decree-Law no. 1,564 extended it to 1982 and in late 1981 the current government extended it until the end of 1985. It is not clear from the legislation available to this author what happened between 1974 and 1977.

14. Together, these two types of deductions could add up to 87.5 percent of the Income tax liability of any Brazilian corporation. It should be noticed, however, that fiscal incentives programs were also available for the Northeast and eventually to economic sectors like tourism, fisheries, and reforestation. The impact of the fiscal incentive program for reforestation in Amazonia has been small. For analyses of this program see Beattie, 1975; Beattie & Ferreira, 1979; Nascimento, 1978; Breger, 1979.

15. If the funds were not used within this period, they would be automatically allocated to FIDAM as mentioned before.

16. These credit lines included funds from the World Bank and the Interamerican Development Bank which were made available to finance cattle raising firms (Hecht, 1982: 51-2; Pompermayer, 1979: 172).

17. Unless otherwise noted, US$ stands for United States dollars at 1982 prices. For the price adjustments in cruzeiros the Fundação Getulio Vargas general price index annual average (Conjuntura Econômica, column 2) was used while US dollar price adjustment was obtained by converting 1982 adjusted cruzeiros into 1982 US dollars using the annual average exchange rate also published by the Fundação Getulio Vargas (Conjuntura Econômica). The original data mentioned in this sentence was calculated from Mahar (1979: 93).

18. Although the policy changes of the laws of Operação Amazonia anticipated that those resources could be allocated to any agricultural and livestock projects; the marked preference by Southern entrepreneurs for cattle raising projects has all but completely dominated the agricultural and livestock category. Official statistics by SUDAM, however, call this category Agropecuária (Agriculture-livestock) but it can be safely substituted by simple cattle raising, as used here (cf. Pompermayer, 1979: 190-1).

19. See Bourne (1978: 146-53); Davis (1977); and Pompermayer (1979) for specific examples of those types of investors.

20. For more on the impact of cattle operations on the Indian populations of Amazonia see Davis (1977); Ianni (1979) and others.

21. Nogueira (1969: 10-12) quoted by Hecht (1982: 118) and Pompermayer (1979: 189).

22. As quoted by Hecht (1982: 80).

23. Cedeplar/UFMG (1977) cited by Pompermayer (1979: 208).

24. Mahar (1979: 123) cites the results of a survey done by SERETE (SERETE S.A./SUDAM, 1972), a consulting firm commissioned by SUDAM. This study included information gathered from 12 ranches: six in eastern Pará, three in southeastern Pará, two in northern Mato Grosso, and one in north central Pará. All located in areas of Tropical terra firme forests. The results of the study indicated that most of these ranches had a net annual profit of approximately US$ 3.00 per ha after 10 years and less than US$ 6.00 after 20 years. More recently the poor financial performance of cattle projects has been confirmed by Hecht (1982). More complete financial and socio-economic analyses of cattle ranching in Amazonia have not yet been done despite of, or perhaps because of, its obvious importance.

25. As discussed in section II.5, the great majority of soils of Amazonia are poor in natural fertility. They are also acidic which, besides provoking aluminum and Manganese toxic effects in most crop plant, causes P2 O5 fertilizer applied to these soils to be converted into unusable compounds (Kamprath, 1972; Sanchez & Isbell, 1979: 41; Foth, 1980: 448-51; Fearnside, 1983: 75). High phosphorous fixation has been said to affect as much as 16 percent of Amazonian soils (Cochran & Sanchez, 1982: 170). Furthermore, the heavy rainfall observed in the region coupled with high percolation rates (due to the good physical features of most Amazonian soils) and low base exchange capacities of the soils, results in serious losses of fertilizers through leaching (Engelstad, 1972: 175).

26. Hecht (1982: 13) reviewed the agronomic literature of cattle raising in tropic areas and found that it generally paints an optimistic picture. While it acknowledges that productivity problems associated with soil degration, soil compaction, cultures adaptability, and weed invasion are serious, it considers these problems to be manageable through soil amendments. and genetic selection. Especially with the creation of the Brazilian Enterprise for Agriculture and Livestock Research-EMBRAPA in 1972 and the creation of the Tropic Humid Agriculture and livestock Research Center-CPATU in 1976, agriculturalists have increased their cattle raising research efforts. CPATU has an aggresive special research program for cattle in raising terra firma called PROPASTO-(Program for Pasture Improvement in Amazonia Legal) to try to recover the degraded pastures that have developed in the region (Hecht, 1982: 180; Cochrane & Sanchez, 1982: 187-91; Alvin, 1978: 247; Skillings & Tcheyan, 1979: 69).

27. This behavior in fact has also been observed in cattle farms of Central America (Parsons, 1976 cited by Alvim, 1978: 248).

28. Hecht (1982: 129, 174) mentions inflation, greater costs than anticipated in the projects, SUDAM's delays in disbursements, and

expense of pasture development and maintainance as other reasons for the proliferation of cattle reformulation and amplification projects approved by SUDAM.

29. Deforestation due to cattle farming and other land use is discussed below.

30. Data obtained from Skillings and Tcheyan (1979: 69), probably at 1978 prices.

31. Besides these federal fiscal benefits, the state of Amazonas and the Municipality of Manaus also give special fiscal relief for firms in the ZFM area. For more details on the basic legislation of the ZFM see Eficaz (1983).

32. Since 1977, SUFRAMA has supported a program to support the establishment of small industries in Ocidental Amazonia. Appendix 13 summarizes the accomplishments of this program. In this case, forest-based sector industries have dominated the investments. Unlike larger projects, furnitures and Joinery industries have accounted for 54 percent of the total investment in forest-based industries indicating a forward linkage with the larger lumber and plywood industries.

33. Forests on slopes between 25 and 45 degrees could only be used for log extraction under rational utilization for permanent yield (Art. 10).

34. Law no. 6,001 of December 19, 1973, Estatuto do Índio (Indian Statute), interpreted the concept of permanent preservation to mean that these forests could be cut provided there was programs or projects for the utilization of the land in agriculture, industry or reforestation. This is a very peculiar interpretation of the concept of permanent preservation.

35. This law also officially created the profession of forester in Brazil.

Section V.2

1. Castelo Branco died suddenly in July of the same year in an airplain accident.

2. For a sample of these studies see the works of: Moran, Smith, Fearnside, Goodland & Irwin, Schmink, Ianni, Benker, Denevan, and others referred to in the bibliography.

3. Naturally some of those reasons were also important factors determining the creation of operacao Amazonia.

4. General Couto e Silva later became one of the most influencial military officers in the various governments that have existed. He has also occupied the position of Minister of State.

5. Galey (1977: 193-4) has suggested that "Amazon-related issues ... provide powerful ammunition for those seeking to score advantage or gain influence across the political spectrum ... (since Amazonia has acquired an) emotional and symbolic meaning for Brazilians."

6. The Northeast, being one of the first areas colonized in Brazil and where the Sesmaria land distribution system was also used, has a substantial problem of land concentration in few hands. As will be discussed later, the previous trend of Center-South Brazilian peasants migration to Amazonia accelerated in 1970s and early 1980s. This has resulted in what Ianni (1979) has called a "counter-land-reform" policy for the source region since the Transamazonica Highway and Colonization Program did not address their land distribution problems.

7. In fact, a study done by FAO in cooperation with IBRA in the late 1970 had concluded that the Transamazonica highway combined with agricultural colonization offered the best chance of absorbing the estimated 309,000 Northeast families underemployed in 1970 (cited by Cardoso & Muller, 1977: 141).

8. The idea of bringing Northeasterners to Amazonia as a means of reducing population presures from those regions had already been used a few years earlier by SUDENE when it promoted an agriculture colonization project partially funded by the World Bank in the Pre-Amazon forest area--the Alto Turi project. The project has had only limited success (Skillings & Tcheyan, 1979: 71, 78-9).

9. Part of these resources was also to be used in an irrigation plan for the Northeast. Subsequent legislation regulating PIN (Decree no. 67,113 of August 26, 1970) established that this program's funds should also be used to finance the construction of new fluvial ports in the region as well as an extensive survey of Amazonian topography, forest cover, geomorphology, soils, and mineral and energy resources later known as Radar da Amazonia Project (RADAM).

10. Among the other sources were the Union's budget allocations as well as resources obtained with the U.S. Agency for International Development-USAID (Smith, 1982: 14).

11. This change was recommended by a FAO report to the Brazilian government according to Cardoso & Muller (1977: 141). There were no other changes in the Estatuto de Terra. Decree no. 68,153 of February 1, 1971 approves the general regulations of INCRA.

12. This was the only way by which the 1969 constitution (art. 4) allowed the federal government to acquire greater control over these

lands.

13. This Decree-Law was regulated by Decree no. 71,615 of December 22, 1972 and changed later by Law 5,917 of September 10, 1973. A few days before President Medici signed Decree-Law no. 1,164, he signed Decree no. 68,443 (March 29, 1971) which declared an area of 64 million ha in Central Amazonia (around Altamira, Pará) as of social interest for expropriation. Private lands in this area would be used for agrarian reform projects and agriculture colonization within the PIN framework (Arruda, 1976: 53).

14. According to Goodman (1978: 324) cited by Mueller (1979: 55) the land redistribution activities supported by PROTERRA did not result in practical terms. Most of PROTERRA resources have been chanelled to finance infrastructure projects and subsidized credit lines to agricultural--including cattle activities in Amazonia and the Northeast (see also Hecht, 1982: 112-3).

15. The existence of PROTERRA has been extended until 1980 by Decree-Law no 1,493 (December 12, 1976) and until 1985 by Decree-Law 1,701 (October 10, 1979).

16. The same occurred to the other fiscal incentive programs mentioned above.

17. Quoted by Henriques, 1972: 9.

18. The first experience in colonization in Amazonia using the PIC approach was in the PIC ouro preto in Rondonia along the Cuiaba-Porto Velho road in an area of 527,879 ha (Arruda 1976: 34-9).

19. There was not any official colonization attempt to settle the 1,056 km Transamazonica stretch from Itaituba to Humaitá (Smith, 1982: 21).

20. Due to IBDF's lack of human and other resources, it is not unusual for some lots to have been completely cleared with no punity (Smith, 1982: 60). SUDENE's Alto Turi colonization project in Maranhão complied with the 50 percent law by keeping 40 percent of the total project area as a simple forest reserve while the balance 10 percent was kept in each settler's farm as a wood lot (Skillings & Tcheyan, 1979: 80). This superior approach was not used by INCRA in its Transamazonica colonization program.

21. Moran (1981; 1983: 304) has found that Amazonian caboclo families participating in the colonization projects were usually capable of picking the better soils for cultivation through native plant association. Their greater acquaintence with the forest and its resources led those families to obtain superior harvests than their neighbor's average. Caboclo families were also more successful in

making use of forest resources by hunting, gathering, and fishing than their neighbors (Moran 1981: 97-113; Smith, 1976b).

Section V.3.

1. Created by Decree no. 74,607 of September 25, 1974.

2. According to the legislation of Operação Amazonia, SUDAM was supposed to develop plans for Amazonian development. During its first years of existence, the superintendency produced two plans: the First Five-year Development Plan and the Primeiro Plano Diretor. Neither of those two plans were ever operative basically for the same reasons that SPVEA's plans before were also not implemented (Mahar, 1979: 13-17). After these, SUDAM prepared the Amazon Development Plan for the period 1972-1974-PDA (SUDAM, 1971), which was a detailed version of the general guidelines of the First National Development Plan-I PND (Brazil, 1971). PDA reiterated the basic elements of the Medicí approach to Amazonian development such as PIN, Transamazonica, small farmer agricultural colonization. PDA was in fact the first Plano de Desenvolvimento da Amazonia-I PDA; but at the time it was not named so.

3. Information available was not sufficient to verify the extent to which private companies have chosen forestry as the activity to undertake in these land tracks. It should be recalled that the 1965 Forest Code determined that forest management in Amazonia should be done under the technical conditions that IBDF was supposed to have developed by 1966. Only in mid-1984 did the Institute make a first attempt at developing those instructions which had constrained any company with interest in those activities.

4. Construction of the Cuiaba-Santarém highway initiated in 1971 by Army Engineering Batallions. It was planned to be completed by 1974 but slow down in its construction allowed it to be open to traffic only in October 1976 (Kleinpenning, 1978:78; Pompermayer, 1979: 213).

5. There seems that a new push by AEA for the promotion of private agriculture colonization is taking place as can be inferred from Tamer (1984: 118-9).

6. For those sawmills dependent on road transportation for wood supply, the seasonality of supply is usually the opposite of the várzea supply system. Unpaved and poorly constructed and maintained roads become impossible to traffic during the rainy season and also create a need for stockpiling for those mills (Mercado, 1980; IBDF, 1983c). It should be mentioned that there is already technology to build all-year-round forest roads in the region. They have been successfully used in the Jarí project discussed in Appendix 4.

7. IBDF, since its creation, has concentrated its activities in the

administration of the fiscal incentives program for reforestation. This program has supported forest plantations of fast growing tree species in the southern parts of the country. Therefore, IBDF has not taken the leadership role in trying to develop a comprehensive forest policy for Amazonia as it is legally encharged.

8. Although this proposal appeared in SUDAM's II PDA as an investment program, here it will be called the Pandolfo proposal because of the important role that the director of the Natural Resources Department of SUDAM has had in designing it and advocating for the adoption of such approach for an Amazonian forest policy.

9. Together with preservation units, the proposal suggested that at least 50 percent of the forest areas in the region, estimated to mean 130 million ha, be kept as land with related conservation objectives.

10. These incentives were only briefly mentioned in the proposal and no further development of the concept was discussed.

11. Due to the legal limitations faced by public service organizations, mixed enterprises, which are supposed to operate as private organizations are more flexible in their decision making and therefore have been increasingly used by the public sector for special activities.

12. The very proposal by SUDAM of a forest policy for Amazonia which was a clear attribution of IBDF may have been a source for disagreement. IBDF, under the Ministry of Agriculture also had problems with SUDAM about the latter's policies towards cattle projects in Amazonia which frequently resulted in deforestation of large areas of dense tropical forests (Ceccato, 1978).

13. This study was apparently related to a more extensive exercise undertaken by IBDF in cooperation with FAO. This exercise, summarized in FAO (1978), examined the various technological, environmental, economic, and institutional aspects of Amazonia Tropical Forest Management and Wood Industrialization based on the Tapajós National Forest created near Santarém and Belterra between the Cuiaba-Santarém Highway and the Tapajós River in 1974.

14. Decree no. 83,518 of May 29, 1979.

15. SUDAM's representative in the group was Dr. Pandolfo.

16. Similar funds were also created for the other fiscal incentives program mentioned above.

17. See Ceccato (1978) for the participation of IBDF in the design of this and other aspects of SUDAM's policies involving forest resources.

18. Disagreement between ALCOA and Brazilian authorities during the Medicí administration combined with strategic decisions by the company stoped the initial project in 1972 (Santos, 1981: 104).

19. Besides the site being explored by MRN, there are other areas in the Trombetas River region where bauxite is found. Some of these areas are under the control of the Aluminum Company of America-ALCOA. In addition, bauxite is also found in (1) Juruti located on the right bank of the Amazon River south of the Trombetas region with an estimated 170 million tons reserve; (2) Almeirim with 400 million tons located in the lower Amazon River on its left bank across from the Xingu River's mouth; and (3) Paragominas, south of Belém with 2,460 million tons (Santos, 1981; Anonymous, n.d.).

20. This area may be increased for the formation of a buffer zone around the mining area and along the railway and port, discussed below.

21. An estimated 4,535 Indians live in the area of influence of the project. A total of US$ 14 million has been allocated to finance activities designed to mitigate the project's impact over these Indians.

22. Decree no. 63,952 of December 31, 1968. Poles considered included: Belém, Santarém, Monte Alegre in Pará; Manaus, Tefé in Amazonas; Macapá in Amapá; Boa Vista in Rondonia; Porto Velho in Roraima; and Rio Branco in Acre.

23. The Itaipu Hydroelectric's 12,000 MW on the Paramá River, the world's largest, is a joint venture of Brazil and Paraguay.

24. Currently, most of this network is already in place and in fact, Belém as well as the Tucuruí station construction site has been supplied with energy produced in the Northeast.

25. The Tucuruí project was not the first hydroelectric project in Amazonia or in tropical South America, although it is unique due to its large size. The first case of daming a river in the tropical forest area of the region was that of Brokopondo in Suriname. This hydroelectric was built on the Suriname River to produce 180 MW to be used mostly on the industrial production of aluminum. Energy production began in 1965. The lake formed—with an average depth of 7.9 m—covered an area of 156,417 ha of pristine tropical forest which was not subject to any clearing operation. Besides the loss of wood resources, the degradation of this biomass resulted in increasing corrosiveness of the water which in effect was to increase the need for frequent turbine parts replacement. Navigation on the lake had also been difficult and dangerous due to floating logs and submerged undergrated tree stumps. Water weeds also became a substantial problem for the lake. These and other environmental effects of this hydroproject are discussed by Goodland (1977), Paiva (1977), and Caufield (1983). Tucuruí was not even the first hydroelectric project

in the Brazilian Amazon. The first one--Coaracy Nunes hydroelectric--is located in the territory of Amapá on the Araguari River 150 km north of Macapá. Construction of this project began in the 1960s but its conclusion was only possible in late 1975 after ELETRONORTE gave it a final push. Its production is small, only 40 MW of installed potency. The reservoir is also small, 2,300 ha, and unlike Brokopondo, it inundated not tropical forest but, for the most part, cerrado. Coaracy Nunes supplied energy to most urban areas of Amapá as well as ICOMI's Manganesemining operations (Goodland, 1977: 81; ELETRONORTE, n.d.(a)). Another small hydroelectric station in the Brazilian Amazon began operation in 1977. The Curuá-Una hydroelectric is located on the river of the same name, 70 km southeast of Santarém in Pará. It produces only 20 MW which is consumed by Santarém. Like Brokopondo, the 8,600 ha lake created inundated an uncleared tropical forest. Some of the same problems found in the Suriname's hydroproject also found in the Curuá-Una, including problems with weeds and corrosion of turbine parts (Goodland, 1977: 81; Junk et al., 1981).

Section V.4

1. Decree-Law no. 1,813 was regulated by Decree no. 86,157 of July 29, 1981 and the limits of the program were increased by Decree-Law no. 1,904 of November 11, 1981 to include the entire municipios that were cut by parallel 8 degrees South.

2. GETAT was restructured by Decree-Law no. 1,799 of August 5, 1980.

3. The usucapião especial legislation (Law no. 6,969 of December 10, 1981; Decree no. 87,040 of March 17, 1982; and Decree no. 87,620 of September 21, 1982) established that "anyone, not being owner of rural or urban land, who has as his for five uninterrupted years, with no opposition, a continuous land area not larger that 25 ha (but as large as 100 ha in Amazonia), where he has lived and made it productive through his work, can obtain property title to the land." (Free translation by the author.) Before this change, it was necessary a period of 20 years. The usucapião especial is applicable to private lands and to terras devolutas but not to (1) areas indespensable to the national security (such as those under INCRA's jurisdiction); and (2) public lands defined not to be terras devolutas such as National, State, and Municipal Parks and Forests; Indian lands; Biological Reserves; Armed Forces lands; and any other public lands. This legislation also determined that those already occupying public lands have preference to be relocated by the competent agency (Valente, 1983; World Bank, 1981: 66; Yokota, 1981).

4. Decrees no. 87,475 of August 16, 1982, no. 87,649 of September 24, 1982, and no. 87,700 of October 12, 1982.

5. Since most of this new land is located in the fertility-poor soils

of Amazonia, it is expected that agriculture production--due to lower and decreasing productivity--will not increase as rapidly.

6. Besides back of trucks and other transportation means, many of these migrants used the services of a bus company that has connected the city of Cascavel in Paraná and Porto Velho. This company began operation in 1972 with a monthly trip, in 1973 there were 2 trips a month, in 1974 there was a bus each week, the next year the trips were daily, and by 1984 the company has 5 buses leaving south Brazil every day to Rondonia (Kuck, 1984).

7. This project was apparently created to occupy areas near the border with Bolivia and is located in poor natural fertility soils. Also contributing to the slow development of this project is the fact that Indians were found within its limits (Arruda, 1976; Mueller, 1980: 147).

8. In late 1977, Mato Grosso state was tranversally divided into two new states. The northern part kept the original name of the state and the southern part is now called Mato Grosso do Sul. This new state division required a redefinition of Amazonia Legal's boundaries which now coincide in its southwestern portion with those of the new state of Mato Grosso. Appendix 12 shows a map of the new Legal Amazonia.

9. Two new projects have been created since the beginning of POLONOROESTE summing a total area of 642,340 ha: Machadinho and Urupá (INCRA, 1984).

10. On September 25, 1984 and as a result of support given by the POLONOROESTE, the third national forest in Amazonia, the Jamarí National Forest, with 215,000 ha was created in Rondonia (Sinal Verde, 1984a).

11. When created in 1974, its estimated area was 600,000 ha. With the final location of the Cuiaba-Santarém road and the availability of better maps, the area was reduced to 531,000 ha (FAO, IBDF, 1980).

12. IBDF in cooperation with FAO through the Projeto de Desenvolvimento e Pesquisa Florestal-PRODEPEF (Forestry Development and Research) began research in the area in 1975. In mid-1977 the government decided to tranfer the responsibility for the execution of forestry research from IBDF to EMBRAPA, although the institute continue to be legally responsible for this type of research. Being IBDF a weak organization and EMBRAPA a public enterprise with greater flexibility of operation especially in haring and training personnel, this tranfer was thought to be a better move than to try to improve IBDF's own research and institutional capability. Through a contract, EMBRAPA received all IBDF's research infrastructure in the country and the responsibility to continue the on going research projects. Since the Tapajós National Forest is still under IBDF control and SUDAM has its Wood Technology Center and its Curuá-Una Experimental Station nearby, EMBRAPA and these two organizations have cooperated sharing costs and

other resources in the undertaking of research in the area, although poorly coordenated among themselves.

13. The rest of the 531,000 ha of the Tapajós National Forest would be allocated for biological reserves, research, and areas for future development. In addition, some 88,600 ha of the national forest had already been converted to non-forest land uses by posseiros as well as colonists brought by INCRA, which inadvertently distributed 61 100-ha plots along the Cuiaba-Santarém road on the national forest grounds (FAO/IBDF, 1980).

14. A new set of classification rules for grading sawn hardwood timber in Brazil was published in 1983 (IBDF, 1983c).

PART THREE

THE FOREST-BASED SECTOR AND THE DEVELOPMENT OF AMAZONIA

CHAPTER VI

The Role of the Forest-Based Sector in Development

As part II of the dissertation has shown, the forest-based sector has played a substantial role in the socio-economic development process of Amazonia. Evidence of this role is found throughout the region's economic history. The relative importance of the sector has probably decreased in the past quarter of a century due to the policies devised by the federal government, especially after the 1964 revolution. It is the objective of this chapter to provide a framework for the understanding of the forest-based sector's role in development, thereby facilitating the discussion of its potential role in the socio-economic development of Amazonia.

The Concept of Development

First, it is necessary to discuss briefly the meaning of development. Society is constituted by human beings with numerous needs. These needs can be seen as providing the main motives used by those individuals in their decision-making process. Through their daily decisions, human beings try to satisfy these needs, thereby improving their life quality. However uninformed or limited the analytical ability of those individuals, they still try to maximize their satisfaction through their decisions. This assumption is at the

heart of the concept of development used here. Development occurs through the provision of the means by which the members of society can pursue their objectives, satisfy their needs, and therefore improve their own quality of life.

In this sense, it is relevant to refer to the work developed in the motivational theory by Marlow (1970). This author has suggested that one way of understanding how individuals are motivated to act in a certain manner is by understanding the needs of any human being. There are five basic groups of human needs that any individual tries to satisfy (or maximize their satisfaction). In decreasing order of importance, they are: (1) physiological, which includes need for air, water, and food, (2) security, which includes needs for safety, order, shelter, and freedom from fear or threat, (3) belonging or love, which includes the need for love, affection, feelings of belonging, and human contact, (4) esteem, which includes the need for self-respect, achievement, and respect from others, and (5) self-actualization, which includes the need to grow, to feel fulfilled, to realize one's potential. The inhabitants of Amazonia also have these needs which, translated into personal objectives, drive their actions. As those individuals achieve their goals, they improve their lives and, therefore, development occurs. Or, as Todaro (1981: 72) puts it:

> Development is both a physical reality and a state of mind in which society has, through some combination of social, economic, and institutional processes, secured the means for obtaining a better life. Whatever the specific components of this better life, development in all societies must have at least the

following three objectives:

> (1) To increase the availability and widen the distribution of basic life-sustaining goods such as food, shelter, health, and protection
>
> (2) To raise levels of living including, in addition to higher incomes, the provision of more jobs, better education and greater attention to cultural and humanistic values, all of which will serve not only to enhance material well-being but also to generate greater individual and national self-esteem
>
> (3) To expand the range of economic and social choice to individuals and nations by freeing them from servitude and dependence, not only in relation to other people and nation-states, but also from the forces of ignorance and human misery.

It is in this sense that development in the Amazon Region is understood here and it is based on this understanding that the role of the forest-based sector in the development process is identified.

Forest-Based Development[1]

The forest-based sector, as seen in the first chapter of the dissertation, produces a series of goods and services that help members of society to satisfy many of their needs. In terms of providing adequate supplies of food, the sector contributes directly and indirectly to its achievement. Forests produce fruits, nuts and other seeds, roots, foliage, honey, fungi, edible oils, spices and other goods which contribute directly to the satisfaction of this need. In addition, forests are involved in the production of wild animal meat such as fish, bird, reptiles, and mammals as well as insects, all of which have been estimated by Dourojeanni (1981: 7) to provide as much as 80 percent of the animal protein consumed by the rural population of

Amazonia. The works of Smith (1976a, 1976b, 1978, 1979), Moran (1981), Goulding (1979, 1980, 1981) and others provide illustrations of this role for the case of Amazonia. Forests also produce foliage that can be used to feed domesticated animals which in turn are consumed by humans.

Forests can also help agricultural food production not only by restoring the degraded soil productivity--through improved texture, structure, and fertility--after the shifting cultivator abandons his field but also by minimizing soil erosion and leaching, regulating water flow, and reducing siltation of irrigation and drainage channels. Forests also help agriculture by being a gene pool from which plant breeders can obtain new genetic material in order to maintain and even increase the productivity of modern crops, "to enhance their nutritive content, to improve their taste (or to restore it), and to resist emergent types of diseases and pests, as well as environmental stresses such as cold and drought." (Myers, 1984: 190) Forests may also act as a buffer against disease and pest epidemics affecting domesticated plants and animals, a feature that has been tried in the Jari project. (See appendix 4.) The species rich tropical forest is also a source of a variety of plant alkaloids which have been found useful to control pests and diseases. The number of goods produced by tropical forests that can help to deal with the food problem is expected to increase as new foods are found and these known ones become more broadly utilized.

Besides their agricultural use, plant alkaloids also have important applications in medicine and industry. In the process of

identifying these uses, the knowledge accumulated by Amerindians through thousands of years of survival in the forest has been found very important. Schultes, (1979) cited by Myers (1983: 64) has found that Indians from north western Amazonia alone have employed over 1,300 plant species as medicines and narcotics. More of those plants and products are being found as ethnobotanists and other researchers undertake further studies.

The security need of human beings can be satisfied by the forest-based sector through the provision of building materials for the construction of shelters. Poles, fences, stakes, furniture, tools, and utensils are some other products frequently made from materials derived from forests.

In the past decade, as a result of restricted supplies and hence higher prices of fossil fuels, the traditional role of forests as a source of energy and its considerable potential for future energy production have become better appreciated. In the form of firewood, pellets or charcoal for domestic consumption (cooking and heating) and industrial consumption, or wood-derived liquid fuels such as ethanol and methanol; wood has contributed to improve the welfare of millions of people. In Amazonia wood consumption for domestic use has been fundamental and its industrial use has been increasing substantially, especially in the wood industry, in thermoelectricity production, and is expected to increase in the mineral processing industries under development in the region.

The forest-based sector also contributes to development by

being a source of income either through the sale of forest products or the sale of labor to forest operations and industry. The income so obtained can be used to buy food or other goods and services in the market, thereby improving the well being of the income earners and their families. Most of the goods mentioned above have been exchanged in the market place for money or in barter transactions. Guns, edible oils, latexes, essential oils, resins, ornamental plants, logs and other wood products, live animals for biomedical research or for pets, skins and furs, are also examples of other forest-based products that have been sources of income.

Many of these products are directly consumed by those who produce them. In addition, many of the exchange transactions are not registered in the official economic statistics, including the case of illegal trade of some forest products such as animal skins. These facts, combined with the positive external economies associated with the forest sector, as discussed below, make it difficult to quantify the real importance of the sector in the socio-economic development process.

Income can also be obtained by the sale of labor. Since forests generally occur or are created in rural areas, many of the direct and indirect jobs created by the sector are, therefore, located in those areas. Wood processing industries are generally located near the resource also due to the bulkiness of the wood raw material and need to reduce transport costs. By doing so, these industries help to reduce the imbalances between economic opportunities in rural and urban areas,

therefore reducing rural-urban migration, and urban unemployment problems (Todaro, 1981: 242-246). In the case of certain parts of Amazonia such as Rondonia and South Para where migrants are arriving in growing numbers, the sector could become an alternative for the generally unsuccessful attempts at agricultural colonization. This possibility, which would mitigate the effects of the massive migration, will be further discussed below.

Besides this locational characteristic, the technology involved in forest-based activities varies from the most simple labor intensive work to capital intensive. This range of technological possibilities is especially important today when capital is expensive and rates of unemployment are high (King, 1980: 520). In fact,

> ... The range of forest industries is so wide that the options for pursuing capital intensive or labor intensive subsectors are readily available.
>
> In addition, within a particular industry, even within the traditionally considered capital intensive forest industries (such as pulp and paper), there is now a similar range of options; further, the labor intensive options are technologically sound and economically and financially feasible (King, 1980: 521).

This gives a country processing forest resources a wide range of options to develop the sector within the specific labor/capital resources picture of the locale.

The forest-based sector has also considerable backward and forward linkages with other sectors in the economy, which spreads the impact of the creation of forest employment.

Westoby (1979: 111) briefly summarized his 1962 work related to the arguments that might justify certain priorities to forest

industries in the attack of underdevelopment in the following way:

> Here was a group of industries based on a renewable resource, a resource which all underdeveloped countries possessed or could create; industries with considerable flexibility both as to scale of operations and technology; industries with pronounced backward and forward linkages, ensuring that their growth would exercise a multiplier effect on the whole economy; industries which, located near the wood resource, offered the prospect of creating new poles of development, checking the squalid centrifugal development that has scarred so many underdeveloped countries; industries producing a wide range of products, many of which correspond to basic needs; products, moreover, with a high income elasticity, enhancing prospects of industry viability once under way; products which could substitute expensive imports and, exported, earn valuable foreign exchange.

The chances for the realization of the forest-based sector's potential for improving the well-being of the local population grows with the increased level of industrial processing and with the increased concern for a greater distribution of the income derived from the sectoral activities.

Wood processing and forest industries contribute to rural development not only by the creation of direct and indirect off-farm employment, but also by the provision of infrastructure services usually associated with those activities. The rest of the country benefits by having access to forest-based goods and by the effects of these activities on the balance of payments either as source of foreign exchange or as savings thereof. Government revenue is also expected to increase with the increase of forest-based activities.

As mentioned above, the real contribution of the forest-based sector to the socio-economic process is usually underestimated in the standard national accounts and economic indicators. Part of the reason

for this is the fact that some of the goods and services produced by the sector are not exchanged in the market place. Even when forest products are traded, their prices often do not reflect their marginal social benefit resulting from the positive externalities associated with their consumption and or production. Examples of this disparity are found in the ecological effects of forests.

> Forests are outwardly grand but fragile ecosystems. They have pronounced microclimatic effects, for they reduce the range of daily temperature variation, help retain a layer of cool moist air, and enhance the local climate. Their overall impact--with consequent widespread benefits to mankind--is to soften the interaction of elements that comprise the ecological system (World Bank, 1978: 13)

When properly managed, forests can reduce the probability of high cost floods and affect the navegability of rivers through the regulation of stream flow. Besides the agricultural land productivity benefits of reducing soil erosion rates by reducing these rates, forests also influence water quality by affecting the siltation process of rivers, canals, and reservoirs--used to keep water for domestic consumption, irrigation, or hydroelectricity production. This characteristic is especially important in the tropical areas where soils are more susceptible to the erosion power of the intense rainy season.

As discussed in chapter III, the role of the tropical forests in Amazonia's hydrologic cycle is substantial. In addition, they provide a unique habitat for hundreds of plants and animal species, many of which cannot survive in deforested environments. They are also the original environment of hundreds of Amerindians. Forests have scientific and

educational values not only for representing a natural gene pool, but also for being a living laboratory where evolution can pursue its course and biological and ecological studies can be conducted.

Finally, forests have recreational and touristic values which in some cases like in Manaus and Belem, have been commercially explored.

Forest-Based Technology Alternatives for Development

There are several ways to produce the various goods and services discussed above. Many of them are naturally produced, but man has started to intervene in the natural processes of these forests to obtain more of some of these goods and services.

As discussed in chapter I, the transformation functions of the forest-based sector or the forest-based technology alternatives for the development of Amazonia can be broadly divided in two main groups: forest activities and forest-based industries. Here, a brief discussion of some of these technology alternatives, as listed in table 15, will be presented.

The existent forest technologies can be divided into three main types: (1) technologies that produce goods and services based on natural forests; (2) Agroforestry technologies; and (3) technologies that convert natural vegetations or degraded lands to tree plantations. Another class of forestry activities technologies is that related to watershed management to maintain or to improve water quality, quantity and timing and, hence, supporting agriculture and/or hydroelecticity production. However, all three types of forest activity technologies

Table 15: Current Alternative Forestry Technologies for Amazonian Development.

1. Utilization of Natural Forests
   a. Preservation of Samples of Ecosystems
      -Biological Reserves
      -National Parks
   b. Gathering of Forest-Based Products
   c. Management of Secondary Forests
      -No Treatment
      -Refining
      -Tropical Shelterwood
      -Underplanting
2. Agroforestry Technologies
3. Tree Plantations

Source: Adapted from OTA, 1984.

mentioned can also be seen as technologies used in watershed management. Therefore, this class will not be discussed here as a separate type.

Utilization of Natural Forests

The technologies that use natural forests can also be divided into three main groups: (1) those that preserve samples of the natural ecosystems (2) the gathering of forest-based products; and (3) the management of secondary forests. The social benefits of maintaining sample ecosystems are mostly of environmental and educational nature. They are associated with the normal working of natural forests such as allowing the continuity of the evolutionary process; providing *in situ* protection of plants and animal species (gene pool); allowing research, educational, and in certain cases cultural and recreational uses; and others. In Brazil, there are presently two basic ways to preserve samples of the natural ecosystems; the creation and management of national parks or biological reserves. National parks can be used for recreation, research, and educational purposes whereas biological reserves can be used for the latter two[2]. Techniques for the identification, design, establishment, and maintainance of these areas have been developed and to a certain extent--as discussed in the next chapter--successfully applied in the Amazon (IBDF, 1979, 1982b; Miller & Glick, 1982; OTA, 1984: 159-67).

The gathering of forest-based products has been practiced in Amazonia for centuries thereby making slightly disturbed forests more

valuable. The collection of <u>drogas do sertao</u>, cacao, rubber latex, Brazil nut, and other plant and animal products has been fundamental in the region's socio-economic history. Despite this substantial <u>de facto</u> importance, the gathering of forest-based products has not received much support from the government, with the exception of rubber production. Research trying to expand this type of technology has been very limited in the region.

Lastly, there are technologies to manage disturbed or secondary forests. Besides the "simple" preservation of sample ecosystems and gathering of forest products, technologies to manage secondary forests are among the most compatible with the special characteristics of the tropical forest ecosystem of Amazonia (Fearnside, 1983; Goodland, 1980). There are two major advantages of these technologies when contrasted with some extensive terra firme agricultural and cattle raising activities on Amazonia's poor soils. First, they do not exclude the eventual possibility of conversion to other land uses that may become biologically and socio-economically possible and desirable. Second, these technologies correspond to land uses that are, for the most part, <u>reversible</u>, i.e., they usually do not modify the ecosystem permanently.

Secondary forests are natural forests that have suffered various degrees of disturbance and are usually more homogeneous than undisturbed mature natural forests. The concept of secondary forests is a broad one and includes not only forests that have been explored just for selected wood species for the past 60 to 80 years but also second

growth forests that invade abandoned cultivation areas. These forests can be managed for the production, at various levels of intensity, of a multitude of goods (wood and nonwood) and services. There are three basic types of technologies in addition to no treatment that can be applied to take advantage of the regenerative power of tropical forests, as discussed in section III.1. From the least to the most intensive, they are:

> <u>No Treatment</u>--No silvicultural treatment is applied. The success of regrowth is dictated by the duration and severity of past forest modifications and by soil quality, moisture availability, and access to the area by missing components of the former forest, including tree seeds and animal life.
>
> <u>Refining</u>--This is also known as improvement felling and timber stand improvement. Some trees are removed to give more growing space to other, more desirable trees. The underlying premise is that potentially valuable trees, unless tended, will be constrained by competition with less valuable trees for light, moisture, or nutrients. It is justified only in forest stands that already contain enough valuable trees to promise an economic crop.
>
> <u>Tropical shelterwood</u>--This treatment consists of removing the upper layer of canopy in one or more cuttings to promote either germination or the growth of existing understory seedlings or saplings. Periodic weeding is necessary.
>
> <u>Underplanting</u>--Trees are planted under some living portion of the former forest to ensure a rapid-growing new crop of acceptable tree species (OTA, 1984: 196).

The no treatment alternative includes clearcutting[3] combined with natural regeneration methods. The wood material so produced is usually used for the production of goods which do not need special species or log sizes and shapes. Examples include charcoal, woodchips

for energy or pulp. They can be strip clearcutting methods as discribed by Jordan (1982) and being currently applied in the Palcazu Valley of the Peruvian Amazon for saw timber production by forest colonists (Hartshorn, 1985). Or they can be "block" clearcutting as being used in Columbia for pulpwood production (NRC. 1982: 131), being attempted in the Jari project (appendix 4) for wood chips for energy and pulpwood production and by the Florestas Rio Doce--a subsidary of the CVRD--in Maranhao for charcoal production. The long term biological and economic sustainability of this type of technology is not known. However, it is commonly accepted that smaller-scale clearings mimic better the natural regeneration process and hence recover more quickly than larger disturbances.

Some of the variations of the refining methods include "liberation thinning", polycyclic, and monocyclic systems. The polycyclic system is the variant that is currently being tried by IBDF and EMBRAPA in the Tapajos National Forest. The successful application of this system has been reported for some Dypterocarp forests in the far East. This system preserves the natural forest structure--tree distribution and arrangement in a forest stand--since it prescribes the periodic harvest of mature trees above a certain girth limit, and elimination of undesirable ones, thus liberating immature trees (Lanly, 1982: 58; OTA, 1984: 1929).

The tropical shelterwood technology type was applied in the dypterocarp forests of Peninsular Malaysia (Malayan Uniform System) but has been abandoned there due labor costs (OTA, 1984: 19).

Underplanting technologies include (1) "enrichment" planting--vacant gaps in the forest are planted with desirable species; (2) "gap" planting--artificially created gaps are created in the forest where desirable species are planted; (3) "Group" planting--clusters of 9 to 25 seedlings are planted in small and artificial gaps of which only one is expected to survive; (4) line planting--desired species are planted in rows or lines cleared in the forest for this purpose.

The financial feasibility of these secondary forest management techniques have been frequently questioned in the literature (Leslie, 1976; Spears, 1980; Gregersen, 1981). Most of these questions have their roots in the diversity of tree species, with different physical mechanical properties, of which only a fraction is exchanged in the market. This characteristic makes logging and transportation costs per unit of wood relatively high. Most of the management techniques described above attempt to deal with this situation by trying to change the forest and decrease the natural diversity of tree species. In sum, they try to create a secondary forest with fewer but, marketable species.

However, in recent years a series of technological changes have provided new approaches and given directions for further improvement of wood yields that can be commercially used from a tropical forest area and from secondary forests. Efforts have been made to increase the number of tree species accepted by the domestic and international markets. Attempts have also been made to develop marketing schemes that combine several species of similar capacity to meet specific

end-use requirements under a single commercial name.

Industrial wood products for which species, size, and shape are not critical factors are fundamental to improving usable wood yield per hectare of forest. Besides the examples mentioned above of wood chip products for energy (firewood), for pulp and paper production, and for charcoal production, there are new and promising approaches for the production of reconstituted wood panels. In addition, improved silvicultural treatments as well as improved harvesting and transportation technologies that reduce logging damage can be researched to increase the productivity of secondary forests at lower costs (Bene et al., 1977: 36; Collardet, 1976; FAO, 1982: 42; various in Forest Products Laboratory, 1978; Gregersen, 1981: 112, 122-3; Hansom, 1983; king, 1977; OTA, 1984: 176-82; Youngs et al., 1978).

The existence of these types of wood uses is expected to shift the emphasis of secondary forest management techniques from species oriented to log quality and volume oriented (Roche, 1979: 110-1). Also, one can expect that by the time the second round of cutting of the forest is executed, many of the secondary species found in the forest will assume a higher value as occurred in Nigeria where in 1950, 90 percent of the total log extraction was accounted for by only 5 species whereas in 1980 the number of species had increased to 40 (Spears, 1980: 39-40).

Agroforestry

The second major type of forest activity technologies is called agroforestry. This type of technology is based on the fact that agriculture, livestock, and forestry activities have not been and need not be mutually exclusive land use alternatives. According to Lundgren & Raintree (1983: 2):

> "Agroforestry is a collective name for land-use systems and technologies where woody perenials (trees, shrubs, palms, bamboos, etc., are deliberately used on the same land management unit as agricultural crops and/or animals, either on the same form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components."

Similar definitions are given in Bene et al. (1977: 39), King & Chandler (1978: 2), and OTA (1984: 220).

> Benefits from introducing trees into cropping systems can vary depending on species selection and can be as diverse as: (a) fuelwood, (b) supplemental forage, (c) commercial timber production, (d) production of edible fruits for home consumption or sale, (e) improved soil fertility through mineral recycling and added nitrogen, if leguminosae species are used, (f) soil conservation, and (g) contributing to stabilizing microclimatic conditions related to adverse climatic conditions such as adverse rainfall conditions, temperature extremes, strong winds and heavy raindrops (Weaver, 1980; cited by IDB, 1982: 24).

This sustainable type of forest technology has received increasing attention in the literature, especially after the work of Bene et al. (1977) and the creation of the International Council for Research in Agroforestry-ICRAF. However, as noted by OTA (1984: 228), most of this work has been more of a qualitative and advocative nature.

The number of technological systems that can be collectively

called agroforestry is very large. OTA (1984: 220-9) has used two basic sets of classification for this large number of alternatives. The first divides agroforestry in (1) agro-silviculture, (2) silvo-pastoral, (3) agro-silvo-pastoral, (4) home gardens, and (5) others. The second classifies agroforestry based on three social-economic production categories: (1) commercial, (2) intermediate, and (3) subsistence agroforestry systems. Other classifications have also been cited by OTA (1984: 224).

It is beyond the scope of this study to enter further details of these technology alternatives. Here it suffices to recognize their existence and role in the promotion of improved welfare for rural populations. For the case of Amazonia, Hecht (1982b) has explored the role of and prospects for agroforestry in the region.

Tree Plantations

The last major type of forest activity technologies is tree plantations. These plantations represent a drastic reduction of the species diversity of the tropical moist forest to one or a few tree species. They can be created to produce wood products and/or non-wood products (fruits, nuts, latex, etc.). Some of the perenial crops planted primarily for non-wood products in Amazonia are rubber, cacao, oil palms, guarana, Brazil nuts and others. In the case of wood production, the advantages of their formation is in the superior productivity--some times as much as 20 times greater than secondary forests--of a product relatively uniform in size and quality. Thus,

tree plantations also reduce harvesting and trasportation costs per unit of wood. Tree plantations have also advantages over annual agriculture because they not only offer more protection against soil erosion, leaching, and compactation but also usually have lower demand for soil nutrients in addition to higher tolerance to the acidity and aluminum toxicity of the Amazonian soils.

Tree plantations can be created by reforesting degraded lands that resulted from prior conversion of the tropical moist forest into farm or grazing land and later abandonned due to decreasing productivity. In Amazonia degraded land—especially from abandonned cattle pastures and from poor agricultural practices like in Zona Bragantina and others—could be recuperated. Tree plantations can also be created by directly converting the natural vegetation, as in the case of the Jari project with its extensive conversion of tropical moist forests to gmelina, pine, and eucalyptus plantations.

There are questions about the long term biological and economic sustainability of tree plantations. The desired greater uniformity of the forest also increases the chances that insects or diseases may affect their productivity. As further discussed in previous chapters and in appendix 4, cacao, rubber, and gmelina plantations illustrate these possibilities in Amazonia. Another aspect that may reduce the productivity of these plantations relates to mineral decline of the soil. Although tree plantations are efficient in nutrient conservation, as mentioned above, they are not as efficient as the natural moist tropical forest with its several nutrient conservation

mechanisms. (cf. section III.1) Diminishing productivity of tree plantations is usually forecasted by most ecologists, which might result in the need for fertilization. Besides these factors which have economic implications, the financial feasibility of these plantations requires special considerations, especially due to the relatively high initial investment and long maturity of this type of investment. Under these conditions, close monitoring, maintainance against fire, insects, and diseases, and research are recommended to keep and improve productivity and economic and biological sustainability of these forests (Alvim, 1978, 1982; Fearnside, 1983; Goodland, 1980: 16-7; Gregersen, 1981: 121-2; Leslie, 1976; Nascimento, 1978; NRC, 1982: 131-9; OTA, 1984: 200-13; Spears, 1980).

The range of forest-based technological alternatives currently available for the promotion of the development of Amazonia requires, simultaneously with their implementation, that substantial research efforts be made not only for the development of new alternatives but also for the adaptation of the existing technologies to the specific ecological subzones found in the region. The mounting pressures over the Amazonian tropical forests will not wait until the level of uncertainty of these technologies can be further reduced.

> The realities of the situation make it necessary to implement development strategies that are based on inadequate knowledge. The central issue is how to apply current knowledge in providing for short-term economic gain without irreversibly precluding the opportunity to attain additional knowledge and technological advancement as a basis for wise long-term utilization. The situation requires that reasonable caution be exerted in applying current knowledges, so as to minimize adverse environmental effects. To do so acknowledges that

current humid tropics development projects are buying time to permit the achievement of long-term, environmentally balanced strategies and new technologies (NRC, 1982: 2).

Notes for Chapter VI

1. This portion of the chapter draws from information obtained from the following sources where further details are available: Bene et al. 1977: 21-30, Dourojeanni, 1981; FAO, 1981; Flores-Roda, 1981; Gottlieb & Mors, 1978; King, 1980; Lovejoy, 1984: 8; McGaughey & Gregersen, 1983; Moran, 1981; Myers, 1983, 1984: 189-297; Nascimento, 1983b; NRC, 1982: 77-92, 270-297; OTA, 1984: 37-59; 167-73; Poore, 1978; Prescott-Allen & Prescott-Allen, 1982; Robbins & Matthews, 1974; Smith, 1976a, 1976b, 1978, 1979; U.S. Interagency Task Force, 1980; Westoby, 1962, 1979; World Bank, 1978.

2. National Parks are areas with exceptional natural characteristics where educational, recreational and scientific activities are combined with fauna, flora, and scenic beauty protection. Biological Reserves are areas where no environmental modifications are permitted except those authorized for scientific purposes (Padua & Quintao, 1982: 314).

3. Leslie (1976: 23-4) has a more restrictive definition that excludes clearcutting. For this author natural management of moist tropical forests means "the utilization of moist tropical forests for their wood and other products in such a way that the initial ecological structure is perpetuated without drastic or permanent change."

CHAPTER VII

Some Forest-Based Development Issues in the Brazilian Amazonia

The pressures on Amazonian forest resources have grown dramatically since the the early 1960s. Before then, ~~r~~rest products dominated the region's economy with little competi n from other products. Since then, the growth of subsidized c ttle raising activities, agricultural colonization, and more recently mining have dominated the attempts by the public sector to bring development to the region. Forest-based sector alternatives, have generally not been part of these attempts, although the availability of the forest resources has kept its historical attractiveness to entrepreneurs. Examples of this are found above with respect to the role of forest-based industries in the investments approved by SUFRAMA as well as their role in salvaging part of the wood resources being wasted in the state of Rondonia. The lack of an adequate forest-based development policy for the region has limited the role the sector which could be further stimulated.

Log production in the region continues to be dominated by the traditional harvest of varzea forests through aviamento type of arrangements, whereas log production from terra firme forests has been mostly a by-product of the conversion of these forests to

non-sustainable agriculture by settlers. The wood industry firms located within the boundaries of SUFRAMA's regions have received some support, but those located or to be located beyond these borders have seen little if any support.

As further discussed below, unchecked deforestation is occurring at high rates and is concentrated in certain parts of the region. Potential siltation problems in dams constructed and in construction in Amazonia are expected to increase as the growth of forestland conversion to other uses continues. Conflicts over land control among peasants, Indians, cattle raisers, and land grabbers, mostly for speculative reasons, continue to exist. These conflicts and the legal "deforestation requirement" to assert possession rights bring additional pressures to the forest ecosystems of Amazonia.

Combined, these aspects indicate the need for a dramatic improvement in management and control of forest land uses. In addition, this improvement is necessary if the forest-based sector is to further contribute to the region's developemnt. For this, a series of institutional issues have been identified and are discussed below.

Institutional Issues

Most of the forest lands of Amazonia are under the status of terra devoluta. As explained in Part II, these are unclaimed public lands which await decision on their final ownership situation. As discussed above, a small proportion of them were made into national parks and biological reserves. A good proportion is Indian land

awaiting regulation of their status. But only a very small area--officially 1,025,000 ha--has been allocated to the creation of the national forests--Caxiuanã, Tapajós, and more recently Jamarí. Most of Amazonia's land is being allocated to agriculture colonization projects and to cattle ranching. A few large tracks belong to private companies and individuals for log production. But, as mentioned above, most of the log production in the region is still dominated by the varzea forests and in some states, log production, though an important part of their economy, is only a by-product of the agriculture frontier expansion.

The concept of national forest was created by the 1965 Forest Code but its legal basis is very narrow, and its role in the management of forest resources in Brazil has been minimal (Nascimento, 1978: 88-93). Both SUDAM and IBDF have suggested the amplification of the role of public forests in Amazonia (section V.3). The Pandolfo proposal in the mid-1970s tried to expand the role of public owned forest lands by the creation of a 50 million ha system of Florestas Regionais de Rendimento which would be managed by a public Forest Enterprise. IBDF's proposal suggested the expansion of the number of national forests whose wood resources would then be harvested by private companies under certain contractual obligations. Neither of the proposals have been approved although apparently the Amazonian forest policy proposal requested by the Figueiredo administration incorporated the national forest concept.

The distrust of the market system as a means to organize forest

output production has led many countries to establish an extensive network of publicly owned forests. These forests are responsible for a large proportion of the wood production of those countries. The world's largest producer of wood products, Canada, is a good example. Over 91.3 percent of the available forest land areas in this country are under the control of the public sector--the provincial government has 81.0 percent whereas the federal government has 10.3 percent. This forest area detains 93 percent of the nearly 20 million m^3 of gross marketable wood in Canada (Bonner, 1982, reproduced in Boulter, 1984: 13).

Although not as dramatic as the case of Canada, a good proportion of the United States commercial forestlands are also under the control of the public sector--nearly 30 percent of a total of 195.3 million ha. Almost two thirds--36 million ha--of the publicly owned commercial forestlands are under the control of the U.S. Forest Service. In 1976, 22.6 percent of all wood volume harvest in the United States came from public commercial forestland; 66 percent of which came from the U.S. Forest Service (USFS, 1982: 121, 158).

Examples of the importance of this type of forestland ownership are not restricted to temperate zone developed countries. In fact, "in most developing countries, the forests are largely or even exclusively under public ownership--whether they are state forests or belong to communal institutions or other public agencies." (FAO, 1971: 1; see also FAO/UNEP, 1983a; Lunly, 1982: 53-6). Many of these developing countries have resorted to forest concession[1] to allow their forests

to be harvested. Indeed, the rapid growth in the production and export of tropical hardwood logs and other wood prducts since the 1950s was possible due to the rapid expansion of these concessions, especially during the 1960s and 1970s. Roughly 120 million ha of tropical forests in 1980 were under this type of arrangement (Pringle, 1976; Schmithusen, 1976, 77, 80; Takeuchi, 1974).

This type of arrangement of forestland ownership, that dominates in some of the most important wood producing nations, represents, in many cases, a subsidization of the wood industry since through this system the capital-consuming land ownership by the industry is avoided. Public ownership of forestland has the advantage that, at least theoretically, lands are more likely to be managed for multiple uses including ones which are important but are not traded in the market place. As mentioned, the differences between the social and financial criteria in forestland management can lead to different decisions. This seems to be even more true in the tropical forests of Amazonia due to its special ecological characteristics. (See Part I.).

In Brazil, the track record of the private sector in managing natural forest resources is not good. The private and rich Parana pine forests (Araucaria angustifolia) of Southern Brazil as well as the tropical forests of Serra do Mar mountain chain area along the southeast coast have been all but completely destroyed. Despite this, the increased role of national forests never really became a political or technical issue and the government has not strengthened the national forest system in the country. Indeed, the very concept of national

forest is not well defined in Brazil. Most of the 15 existing national forests--corresponding to a total of only 1,068,261 ha--were created in the 1940s by the National Institute for Parana Pine as forest parks, mostly located in the south and southeast regions of the country. These parks were originally created as forest research areas and are relatively very small in size. With the advent of the 1965 Forest Code, these forest parks were transformed into national forests where they were given the additional purpose to serve "economic, technical, or social objectives." But, a paragraph in the 1965 Forest Code is nearly all the current legislation on the subject (Nascimento, 1978: 88-93; Filho et al, 1983). Only 3 national forests are in Amazonia, although they have 95 percent of the total national forest areas in the country.

Less dynamic and less prepared than the National Parks Department, the Department of Forest Economics of IBDF was apparently unable to take advantage of the disposition of the Figueiredo administration that resulted in the dramatic increase in the number and area of conservation units in Amazonia. Only one new national forest--Jamarí National Forest with 215,000 ha--was created in this period as contrasted by 8 new conservation units up to 1982--5 national parks and 3 biological reserves with a total of 8.6 million ha.

A definition on an overall forest policy for Amazonia is required, given (1) the limited potential role of agriculture in the Amazon region due to its peculiar environment characteristics including poor soils, (2) the substantial volume of wood resources existing in

the region, (3) depletion of Asian and African tropical forests (Myers, 1980, 1984; Pringle, 1976; Takeuchi, 1974), and (4) favorable projections about wood prices in the international market and increased Brazilian hardwood production (FAO, Jaakko Poyry estimates quoted in McGaughey & Gregersen, 1983: Appendix III.A; various cited by Gray, 1983: 5-6; McGaughey & Gregersen, 1983: 40-1). This policy necessarily requires definitions on how the forest ownership, management, harvesting, industrialization, and marketing are to be divided between the public and private sectors.

In this context, the role of the traditional varzea and terra firme wood production systems should be carefully examined since their continuous existence, among other things, drives log prices down and therefore may affect the financial feasibility of alternative wood production arrangements. The social impact of actions to control these systems, if desired, as well as mitigating measures should also be considered.

But if the lack of a specific forest policy for the Brazilian Amazon is a problem for the forest-based development in the region, it also presents an opportunity for a careful examination of alternatives. The rapid growth of wood production from tropical forest in Southeast Asia since the late sixties has raised several issues and much research has been done to address them. Especially, the works of Schmithusen (1976, 1977, 1980), FAO (1971) and Gray (1983) addressing forest concession related issues are important sources from which Brazilian policy makers and analysts can draw information to design alternatives

for Amazonian tropical forests. Also, the current attempts at managing the Tapajós National Forest may also provide an excellent opportunity to experiment with different institutional arrangements for concessions. This research would provide further information for decision-makers on the operational aspects of different institutional alternatives.

Besides the need for a forest policy for the Amazonian Region, there is the need for a Public Forestry Administration which is capable of executing the various tasks necessary for the promotion of forest-based development in the region. The weaknesses of Forest Public Administrations are not a peculiar characteristic of the Brazilian agency (FAO, 1982: 30; McGaughey & Gregersen, 1983: 157-64). Theoretically at the same level as the much more powerful INCRA used to be—INCRA now is at an even higher level as a ministry—, IBDF is frequently referred to as a third class organization within the Ministry of Agriculture. This very type of administrative dependency has been found to be an explanation for the poor performance of most Forest Public Administrations.

> The administrative dependence of forestry institutes on ministries of agriculture, particularly in countries with potentially important forest resources, limits the political capacity of their directors to obtain increased budgetary allotments and to generate and get new projects approved. Food problems exert pressure on the ministries of agriculture, and make it essential for them to allocate most of the resources to activities and projects that will increase food production and productivity. Most of the long-term projects are projects for expanding the agricultural frontier, such as those for irrigation and rural settlements in tropical areas. This is why, in some countries, the very first agency to limit or cut the budget of forestry institutes is the ministry of

agriculture itself (McGaughey & Gregersen, 1983, 160).

IBDF lacks leadership capacity, skilled line and staff personnel, financial resources and political support and power to adequately meet its mandated responsibilities. But forest-based development in Amazonia--as well as in other parts of the country--require an organization capable of assuming the leadership role for the active promotion of this type of development. It needs to be able to operate successfully in its external organizational environment--both in the private and public sectors as well as international organizations--such as the public in general, decision-makers, other government agencies, and private enterprises (FAO, 1982: 34-5; Nascimento, 1983a). It needs to be prepared to cooperate with public agencies like SUDAM, BASA, FUNAI, INCRA, ELETRONORTE, and others--as discussed in the issues above--in order to promote forest-based development in Amazonia.

Chapter VI of the dissertation showed, among other things, the importance of research for the successful application and development of forest-based technologies in Amazonia. As discussed, forestry research in Brazil is the legal responsibility of IBDF. The institute, however, transferred the execution of forestry research as well as its research infrastructure to EMBRAPA in 1977. But forestry research under EMBRAPA suffers the same lack of priority in resources allocation as does IBDF under the ministry of agriculture. Forestry research is one in over 30 research lines in that enterprise. In addition, the few resources available for forestry research in EMBRAPA are allocated in greater

proportions to other regions of the country, mostly for forest plantation research, and apparently with little concern for income distribution effects. EMBRAPA also limits its research to biological research and no wood and other forest products technology and little forestry economics and planning research are undertaken by EMBRAPA. The range of research needs with respect to tropical forests is large (UNESCO/UNEP/FAO, 1978; World Bank/FAO, 1981) and needs proper institutional support to be properly conducted.

While forestry research in Brazil is far from ideal, forestry extension services--both for forestry activities and industries--are nonexistent. IBDF is also legally charged with this task, but so far it has not organized this activity within its structure.

Forest education at professional and technical levels is also largely inadequate for Amazonia's needs. As mentioned, forest education in Brazil started in the early 1960s in Southeast Brazil where over 90 percent of the currently existing forest schools are located. With the growth of fiscal incentives program for reforestation, which began shortly after the first foresters graduated, forestry education has been biased toward the biological aspects of tree plantation in South and Southeast Brazil. A stronger Forestry Public Administration should be able to promote the shift of education emphasis to attend the needs for human resources at professional and technical levels of the Amazon region.

There are also constraints for the financing of forest-based activities in Amazonia which should be further investigated. The forest

financing arrangements of SUFRAMA, SUDAM, BASA, and IBDF, as mentioned above, have had limited effect in supporting forest-based sector activities in Amazonia.

FAO (1982: 31) has suggested to every country with regard to the tropical forests to take the following measures to improve their institutional forest situation:

a) to ensure the efficient functioning of an institutional framework, with public and private sector;

b) to ensure that the Public Forestry Administration, as the institution with main responsibility for tropical forest resources management enjoys suitable standing within the country's institutional structure;

c) to supply the Public Forestry Administration with the necessary powers for strong development in the field and swift executive action;

d) to guarantee coordination and harmony among the institutions having to do with tropical forest resources and with the populations concerned, establishing clear lines of responsibility and authority; and

e) to amplify and reinforce the Public Forestry Administration field units, starting with areas of the highest priority, i.e. the most conflictive or critical, at the same time setting a target period (e.g. 10-15 years) by which such field units should have attained full operational maturity.

Brazil should certainly consider these measures if the forest-based sector is to improve its participation in the Amazonia development process.

In sum, IBDF--or other more appropriate new organization--should become able to know and understand the forest-based sector itself, its organizational environments and

actors. It also needs to effectively generate, select, implement, monitor, and evaluate policies, strategies, and projects which promote forestry sector development.

Deforestation

Meanwhile, the pressures on forest resources of the region continue to mount. The agriculture colonization rush to the Northwest and Eastern Regions of Amazonia recently further increased by the Figueiredo administration's policies, combined with subsidized cattle raising activities are the two single most important factors in the increasing deforestation rate observed in Amazonia. Table 16 shows the results of studies done by IBDF's program for the monitoring of deforestation in Amazonia through the use of satellite pictures. Although the deforestation numbers--which have been considered to be underestimations--represent relatively only a small fraction of Amazonia's total area, the rate at which this deforestation is increasing is very high. In addition, it should be noticed that this deforestation is concentrated in certain parts of Amazonia which can bring more damaging consequences from these conversion activities. Not surprisingly, Rondonia shows one of the highest rates of deforestation in the region (Bunker, 1981; Denevan, 1981; Fearnside, 1982, 1984b; Hecht, 1981; Myers, 1980; Oldfield, 1981; Salati & Vose, 1984; Sioli, 1980). The increased number of activities discussed above in both the Greater Carajas Program area in South

Table 16 Deforested Area and Growth Rate in the Amazon Region for selected Years.

State and Territory (S & T)	Area Deforested as of (1,000 ha) 1975	1978	1980	1980 Deforested Area as a % of S & T Area‡	Average Annual Deforestation Growth Rate (%) 1975-78	1978-80
Mato Grosso	1,012.4	2,835.5	5,329.9	6.05	41.0	37.1
Pará	865.4	2,244.5	3,391.3	2.76	37.4	22.9
Goiás+	350.7	1,028.8	1,145.6	4.01	43.2	5.6
Maranhão+	294.0	733.4	1,067.1	4.14	35.6	20.6
Subtotal	2,522.5	6,842.2	10,933.9	..	39.5	26.4
Rondonia	121.6	418.4	757.9	3.12	50.1	34.6
Acre	116.5	246.4	462.6	3.03	28.4	37.0
Amazonas	77.9	178.5	n.a.	0.11‡‡	31.8	n.a.
Amapá	15.2	17.0	n.a.	1.12‡‡	3.8	n.a.
Roraima	5.5	14.3	117.0++	0.51++	35.5	69.1++
SubTotal	336.7	874.6	..	..	37.5	..
Legal Amazonia	2,859.2	7,716.8	..	..	39.2	..

Numbers may not add due to rounding.

‡ For the total area of the states and territories see appendix 11.
‡‡ Based on data for 1978.
\+ States with only part of their total area in Legal Amazonia.
++ Based on data for 1982.

Source: Adapted and Calculated from IBDF, 1983a; 1983b; and IBGE, 1981.

Para and Maranhao and the POLONORDESTE area in Rondonia and western Mato Grosso, are likely to further increase the deforestation in these parts of Amazonia.

Reducing this rate of deforestation and at the same time promoting development in the region through the forest-based sector demands a comprehensive approach. The legal bias of current legislation which has deep historical roots, especially in parts of the Estatuto da terra, needs to be corrected. As discussed in section V.1, the requirements of cultura efetiva e morada habitual (living and effectively cultivating the land) for the granting of the right of possession (direito de posse) to unclaimed public land and private lands subject to usucapiao (section V.4), has resulted in deforestation. Technology alternatives which make use of the natural tropical forest should be recognized as sufficient evidence for acquisition of the right of possession. Such a change is expected to help reduce the growing pressures for the conversion of the tropical forest to other land uses simply to comply with an inappropriate requirement. Proper regulations, however, are necessary to avoid abuses of such an approach.

Land speculation by land grabbers, cattle ranchers, and even small peasants participating in the industria de posse has also been a major cause of deforestation in the region since they also have to comply with the same cultura efetiva e morada habitual requirement to obtain the right of possession. Measures to reduce

these speculative gains should be devised and implemented--increased land taxation, for instance--not only to reduce this motivation for deforestation, but also to improve land use in the region.

The subsidization of cattle ranching in tropical forest areas by SUDAM has to be reexamined if this cause of deforestation and degradation of the region's landscape is to be diminished. This land use has been frequently criticized for its damaging effects to the region's ecosystem and very limited socio-economic impact. The powerful Association of Amazonian Entrepreneurs, however, has been able to keep the support of SUDAM to the activity going even against the superintendencia's own stated policy of not approving this type of project in tropical forest areas. The coordinated actions of several actors may be required to promote the suggested reexamination.

The great migration rate being observed to parts of Amazonia needs to be lessened. The alleviation of push factors from origin regions such as the sale of small holdings, and the reduced availability of urban employment, are little affected by forest-based sector policies. However, the availability of rural employment opportunities has been affected and could be further improved through the sector (Beattie & Ferreira, 1979). It is also clear that better land distribution in the origin regions instead of the counter-land reform policies currently applied would keep many from moving to the Amazonian frontier. Pull factors such as improved accessibility are more difficult to affect, but the

attractiveness of areas like Rondonia would be expected to decrease as realistic information about the lack of fertility of the soils of the land not yet distributed as well as the difficulties of access to land were made more available. (See section V.4.)

Some of these measures, besides being beyond the direct action of any existing single public organization, are difficult to implement and are of uncertain effectiveness. More under the control of IBDF, for instance, are measures to promote the improvement of the welfare of Amazonian rural population through the use of forest-based technology alternatives discussed in chapter VI.

Preserving Samples of Amazonian Ecosystems

One of the solutions to the deforestation problem is to preserve samples of the region's ecosystems. IBDF has been relatively successful in pursuing this strategy. The increased deforestation pressures in Amazonia resulting from Figueiredo actions towards the region, contrasted with his willingness to create new conservation units in the country. Up to 1972, Brazil had only a little over 1.5 million ha of preservation areas distributed in 16 national parks and 4 biological reserves, none of which located in tropical forest areas of Amazonia. When Figueiredo came to power in 1979, only one extra national park and one small biological reserve had been created in the last months of the Medici administration. The park was the one-million ha Amazonia National Park, the first in the tropical forests of the region and is located

west of the city of Itaituba and includes areas in the states of Para and Amazonas. Although the creation of this park represented an increase of more than 60 percent in preserved area in Brazil, the total corresponded to not even 0.3 percent of the country's total area.

Two factors seem to have contributed to Figueiredo's decision to substantially change this situation. The first relates to the same forest crisis that led the president to create a working group to study and prepare measures for formulating a forest policy for the Brazilian Amazon Region, as discussed above in section V.3. However, conservation units, which are created by decree, are much easier for the president to approve than for him to sign a new forest policy, perhaps in the form of a law.

The second factor relates to the fact that the National Parks Department of IBDF had been studying the conservation needs of Amazonia since 1975 and by that time was already prepared to publish the first phase of a new program for the creation of conservation units. These studies defined as a principle that each one of 7 identified geographic provinces in Amazonia should have an average of 6 conservation units. To select these units, these studies gave first priority to those areas thought to have been Quaternary Refuges. (See section III.1.) This criterion was seen as one way of improving the chances of preserving most of the biological diversity found in the region. Also, the studies justified the need for larger areas per unit of conservation as a means of improving

the survival chances of most of these species (Wetterberg et al., 1976; IBDF, 1979). The existence of these studies substantially facilitated the creation by Figueiredo of national parks and biological reserves in Amazonia, thereby reducing some of the forest crisis pressures of the period.

As table 17 indicates, the president approved, from 1979 to 1982, the creation in the Legal Amazonia of 5 new national parks and 3 biological reserves--most of which in areas dominated by tropical forest vegetation--increasing the total area of conservation units in the region to 8.6 million ha[a]. More units, as also illustrated by this table, have been proposed by IBDF, which expects the total preservation area in Amazonia to reach 18.5 million ha. Figure 55 shows the location of the existing national parks and biological reserves in Legal Amazonia as of 1982.

Although an important and necessary first step, the simple creation of these conservation units is not sufficient to guarantee their services to Brazil and the rest of humanity in perpetuity. In some of the Amazonian conservation units, Amerindians have been found within their boundaries. By law, the creation of Indian Reserves has legal precedence to any other land use. These units are also not immune to the increasing migratory pressures in parts of the region. Some have been invaded by posseiros, who, although they have no squatters right over the land, do destroy the natural environment. Also by law, they will have to be compensated by IBDF for the "improvements" they have so made to these areas. Cattle

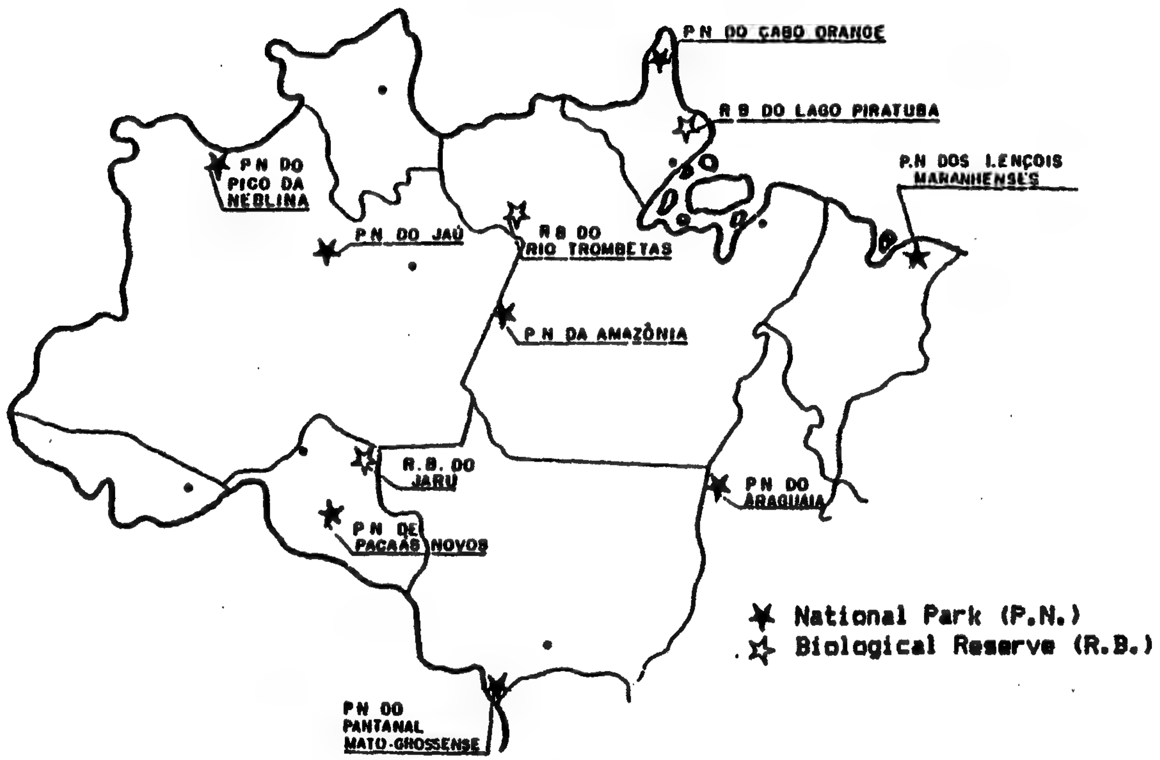
Table 17: Created and Proposed National Parks and Biological Reserves in Legal Amazonia (as of 1982).

	Name	Year of Establishment	Area (ha)
CREATED			
.National Parks	Araguaia	1959	562,312
	Amazonia*	1974	1,000,000
	Pico da Neblina*	1979	2,200,000
	Pacaás Novos*	1979	765,000
	Jaú*	1980	2,272,000
	Cabo Orange*	1980	619,000
	Pantanal	1982	135,000
			7,553,312
.Biological Reserves	Rio Trombetas*	1979	385,000
	Jaru*	1979	26[illegible],150
	Lago Piratuba*	1980	395,000
			1,048,150
			8,601,462
PROPOSED			
.National Parks	Rio Branco*		2,345,000
	Murador		430,000
	Serra do Divisor*		605,000
			3,380,000
.Biological Reserves	Oiapoque*		1,095,000
	Marajó*		88,900
	Guaporé*		680,000
	Mucajai*		667,600
	Rio Anauá*		250,000
	Abufari*		250,000
			3,031,500
			6,411,500

* Dominated by tropical forest vegetation.

Source: Modified from IBDF (1982) and Pádua & Quintão (1982).

Figure 55: Map Showing the Location of Existent National Parks and Biological Reserves in Legal Amazonia (as of 1982).



Source: Modified from IBDF, 1982.

raisers are also known to have invaded some conservation units which, in many instances, together with posseiros, are blamed for starting fires which can spread over large areas of the units. Illegal wood extraction, hunting, and collection of other forest products are also common. Many of these problems result from the lack of financial and human resources to run the conservation unit system. Most of these problems are likely to increase as Amazonia becomes more accessible and populated.

Besides these problems, national parks and biological reserves in Brazil have an institutional limitation. The relative easiness of creation of these units by simple decree also makes it easy to eliminate them. When first created in 1961, the Chapada dos Veadeiros--then called Tocantins--National Park had 640,000 ha. In 1972, the park was diminished to 171,524 ha and in 1981 further reduced to only 60,000 ha, less than 10 percent of its original area. This reduction in size resulted from the _de facto_ verification that most of the park area had already been irreversibly converted to other land uses. Parks have also been eliminated for the construction of major civil projects as has happened with the National Parks of Paulo Afonso and Sete Quedas for the construction of hydroelectric power plants. Or roads are allowed to cross them, as the highway authorized by Figueiredo in late 1982 through the Araguaia National Park to connect the Belem-Brasilia highway with the SUDAM supported cattle producing areas of eastern Mato Grosso. This episode delivered the final blow

which resulted in the resignation of IBDF's director of National Parks as a form of protest against the poor situation that most conservation units are found (IBDF, 1979, 1982b; Padua & Quintao, 1982; Veja, 1984a; Wetterberg et al., 1976; Wetterberg & Padua, 1978).

As the number of conservation units in Brazil increase and the human pressures on those areas grow, more and more financial and human resources are needed to guarantee their existence over time. Besides that, the very creation of those units represent social opportunity costs to Brazilians for allocating these land resources to permanent conservation uses instead of to the best alternative productive land use. The possibilities for some of these units to generate some revenue from tourism and recreation to help finance such costs are reduced because (1) biological reserves cannot be used for those objectives, (2) the current emphasis in the creation of conservation units for their species richness importance rather than for exceptional natural monument features, and (3) the low average income of the Brazilian population which implies a low demand for recreation and tourism services.

It is likely, therefore, that the conservation units will continue to be underfunded in this developing country. However, since much of the benefits from tropical forest preservation, such as wonder drugs for medical, industrial or agricultural uses and other forest goods (as discussed above) are likely to accrue to those who can pay for them--mostly the residents of rich

countries--, developed nations should be prepared to cover part of the social and financial costs of conservation in Brazil and in other less developed countries. By sharing these costs and supporting measures designed to reduce the pressures over tropical forests, these rich nations will be able to increase the chances that proper preservation of these forests will exist for the benefit of humanity. This and other measures have also been suggested by IUCN (1980) and Myers (1984: 328-32). Private non-profit organizations such as the (U.S.) Nature Conservancy in Costa Rica are already contributing in this faction (Barbard, 1982).

Forest-Based Colonization: Alternative to Agricultural Colonization

But even if IBDF were able to properly maintain parks and reserves and create new ones, this will not significantly improve the welfare of the growing rural population of Amazonia. For them, it is necessary to devise forest-based technological and institutional alternatives for the purpose of improving their standards of living, avoiding the past failures of agricultural colonization in the region.

Various types of forest-based technologies were discussed in chapter VI, which have been and could be further used for this purpose. There are the gathering of forest-based products and agroforestry technologies which could be stimulated to be used by the individual land owners thereby overcoming the limitations of

agriculture on the poor soils of most of Amazonia. Also, there are productive tree plantation technologies which can earn incomes while they are being used to recuperate the abandoned and degraded land previously used for annual crops or cattle rasing.

There are also the technologies for the management of secondary forests. In this case, however, the large tracks of forests generally needed for this type of land use make it necessary to create innovative institutional arrangements for the proper management of these forests. The current pattern of private land ownership promoted by INCRA--generally 100 ha plots--are not appropriate for this type of technology. Forest-based colonization based on the management of secondary forests in areas where this type of land structure exist or is created seems very difficult at first sight. There are a few innovative institutional approaches that can be used to make possible the collective management, exploitation, and maintainance and even industrialization and marketing of forest products from a tropical forest unit made up of several land tracks individually owned. These individual owners could associate themselves in cooperatives. The cooperative could be responsible for the industrialization and marketing of wood products as is apparantly the case of the Palcazu Valley project in Peru (Hartshorn, 1985). It could also involve collective management of the forest resources of the forest area such as the case in Venezuela mentioned in UNESCO/UNEP/FAO (1970: 537). Other examples have been described by Christiansen (1979) for Mexico, Guatemala,

and Honduras.

For the case of new colonization projects to be developed in tropical forest areas with appropriate wood resources for management, the approach can be even more innovative. This may involve not only the joint management of the forest unit and industrial and marketing operations but also its joint ownership. Thus, individual forest colonists would not have a specific plot of land that they could call their own. They would have instead a share of the forest enterprise as well as jobs for themselves and their family members. The families would, therefore, derive income not only from their labor effort, but also from the shared profits from the company.

These approaches can be used to improve the welfare of not only new migrants to Amazonia but also of the caboclo population. The knowledge of the forest of these caboclos should be especially welcome in those enterprises.

It is likely that these approaches would need relatively more land per family benefitted than the traditional agricultural colonization approach. But, unlike the agricultural approach--especially those based on annual crops--, the sustainability over time of secondary forest management seems to be much more probable.

A foreseeable criticism of the joint ownership and management type of institutional arrangement is the perception that most colonists want to have a piece of land that they can call their

own. In the past two decades, government officials promoted increased income levels for the Amazonian colonists through the sale of surplus agricultural production, generally based on annual crops. Throughout the region's history this approach has been found to be unsuccessful (see part III). The close relationship between land ownership and the ability to produce this type of surplus combined with their previous experiences in other parts of Brazil have led many colonists to see the ownership of a piece of land as a necessary condition for the improvement of their welfare. However, land is not an end in itself, land is just one of the factors of production required for the generation of income in kind or in cash which, in fact, is what can be converted into increased welfare. Land ownership is not in all cases a necessary condition for the improvement of the lives of the rural poor in Amazonia. The necessary condition is their ability to increase their income levels.

Forests and Indians

As discussed in sections III.2 and chapters IV and V, the estimated 3.75 million Indians believed to have existed in the "Great Amazonia" at the time the first Europeans arrived in the region, have decreased to a small fraction of this original number. Throughout the region's history, they were killed or forced into slavery. They died from diseases brought by the Europeans, lost their land, and lost their ethnic identity. In the past decades, cattle ranchers, migrants, miners, and land speculators have arrived

in Amazonia in growing numbers, especially since the early 1960s. This has meant that the remaining Brazilian Indians have suffered a growing challenge to their survival. The new roads have cut through their lands bringing with them cattle ranchers and other land speculators, migrants, and mining companies invading and fighting for their traditional lands. They participated in this general conflict for the control of the land, but they continue to die in this fight or from the same diseases that have killed most of their ancestors (c.f. Davis, 1983; Oliveira, 1984: 295-310). The prospects for their long term survival, given the growth of economic activities, do not seem to be good.

Indian areas in Amazonia have been reduced systematically for centuries but they still represent a substantial proportion of the region. (See Table 18.) In Amazonia there are more than 98 percent of the identified indian lands and nearly 60 percent of the Brazilian Indian population. As new Indian community groups are still being found, and as the lands of identified groups are surveyed, this area is expected to increase. There are two forces working against each other here. On the one hand, there is a tendency for the traditional Indian community areas to be reduced in size by FUNAI as it officially identifies the area. On the other hand, only 12 of the 24 Indian areas of the regional division 1--which corresponds to the state of Amazonas and has the largest Indian population and area--have been measured. As these 12 Indian areas are measured, the total Indian area in Amazonia is expected to

Table 18: Indian Areas in Amazonia.

Regional Divisions	Headquarters	Indian Lands		
		Number	Area (ha)	Population
1	Manaus	24	8,518,025	27,632
2	Belém	22	10,009,524	6,562
5	Cuiaba	26	2,741,756	3,293
6	São Luiz	15	1,835,912	8,436
7	Goiânia	5	577,284	2,146
8	Porto Velho	38	5,566,494	5,225
10	Boa Vista	45	5,298,037	23,007
A.A. Barra do Garças		7	1,198,467	4,063
P.I. do Araguaia		2	1,455,250	1,301
P.I. do Xingu		2	2,910,816	1,946
AMAZONIA		186	40,111,565	83,614
BRAZIL		256	41,009,630	145,397

A.A.= Autonomous Agency (Ajudância Autonôma).
P.I.= Indian Park (Parque Indigena).

Source: Modified from FUNAI, 1981.

be increased substantially.

Although some progress has been made in the recent past by the Fundacao Nacional do Indio-FUNAI (National Indian Foundation) of the Ministry of Interior in dealing with this situation, its efforts are frequently criticized from all sides of the issue.

There is a role for the forest-based sector to improve the quality of life of the Amerindians. They are in fact the only human beings who know how to survive in the Amazon tropical forests, without destroying them, through proven technologies that they have applied for centuries. (See section III.2.) Their expertise has been increasingly appreciated by the scientific communities which try to learn about them. Forest-based technologies that utilize the natural forests are the most compatible with their life styles, and, therefore, could be used to help these individuals in their successful integration into the national society.

As Brazilian antropologist Alcides Ramos (1980: 227) notes:

> ...The best way to improve Indian productivity is not by whites engaging the Indians as a labour source after having occupied the latter's land, but by finding ways to make concrete the economic potential that the Indian groups already have.

In fact, there are successful examples of the forest-based sector role in the integration process of Indians in Amazonia. A group that was almost extinct in the 1950s, but which was able to make a dramatic comeback, has become successful commercial gatherers of Brazil nuts from the forests of their reserve. This is the case of the Gavioes in the state of Pará, who provide "the most clear-cut instance

of economic integration of an Indian community into the national economy ... without a loss of ethnic identity." (Ramos, 1980: 226)

The forest-based technologies compatible with their culture and phase of acculturation mentioned in the previous chapter—especially the ones that utilize natural forests as well as agroforestry technologies—can be further utilized by Indian communities in their integration process. These technologies are likely to be most useful for those groups in the "permanent contact" and "integrated" phases of their integration process into the national society (World Bank, 1982: 78). The current Brazilian legislation on Indian affairs (FUNAI, 1983; Brazil, 1982) allows such concepts. Collaboration between IBDF and FUNAI is recommendable so as to devise appropriate arrangements to implement it. Indian Reserves also have a substantial role in the conservation of tropical forest. This role should also be jointly studied by IBDF and FUNAI.

Forests and Hydroelectricity in Amazonia

In general, hydroelectricity is closely related to forests due to the latter's role in the quality, quantity and timing of water resources of a watershed. As mentioned in section V.5, hydroelectricity has had a strong start in Amazonia through the Tucurui power station and, as discussed below, is expected to further increase in importance in the region as the mining and mineral processing industries expand. Two basic issues related to the forest-based sector and hydroelecticity will be discussed here. The first relates to the

wood resources existent in the areas of the reservoirs and the second relates to watershed management.

The 243,000 ha of the Tucurui reservoir is for the most part covered with tropical forest. Since the lake's average depth will vary from 16 to 20 m, most of the unremoved forest canopy will be exposed. Despite the fact that the first surveys of the hydroelectric potential of the site date from the work of ENERAM in the early 1970s and that by 1974 construction of the Tucurui project had been decided, it would be only in 1977 that the issue of the use of the forest would begin to be considered. That year, SUDAM published a preliminary study which addressed the issue. A forest inventory was undertaken on 161,000 ha of which 14,750 ha were found to be already converted to pasture or abandoned as secondary forest. One hundred and seventy eight tree species were identified in the area and the average roundwood volume (without bark) with DBH--diameter at breast height--superior to 40 cm was estimated to be 153.85 m^3 per hectare. Since inundation of the reservoir at that time was being projected for 1980, SUDAM suggested that the clearing of such a large area in such a small time period could only be done by the same mixed enterprise that it had proposed one year earlier in the II PDA. SUDAM also suggested that a 86,500 ha forest area located down the Tocantins River and close to the dam be allocated for forest management. There the heavy investments in equipment and human resources made to clear and use the Tucurui reservoir forests could be used afterward. The forest management of such an area would allow a continuous use of the investments made

(SUDAM, 1977).

Still in 1977, ELETROBRAS received the results of a study it had commissioned on the Brokopondo Hydroelectric project in Suriname. This study indicated several adverse environmental consequences of not clearing the tropical forest of the Brokopondo reservoir[5] (Paiva, 1977). In the following year, 1978, ELETRONORTE received the results of another study assessing the environmental impact of the Tucurui hydroproject. Among other recommendations, this study suggested that a forest inventory of the reservoir area and an economic analysis be conducted so as to design a site-specific clearance plan for the reservoir (Goodland, 1978). However, it would be only in 1979 that the first negotiations between ELETRONORTE and IBDF began to define the approach to be adopted to exploit the wood resources of the reservoir. It was then defined that the wood would be exploited by private sector firm(s) which would compete for an authorization from IBDF to do so. In January 1980, IBDF conducted public auction for the harvesting of the wood of the Tucurui reservoir to which no private firm applied. Another auction was conducted by IBDF in May of 1980 to which only one firm, Empresa Agropecuária CAPEMI Industria e Comércio Ltda applied for. The proposal from the firm, despite the fact that it had no prior experience in the forest sector, was accepted by the government. CAPEMI would have to pay IBDF royalty for the right to exploit the area. CAPEMI contracted a loan from the French bank Lazard Freres for a total of US$ 100 million to finance its operations in Tucurui. The bank assumed the responsibility of marketing the timber harvest in

Europe. The company was responsible for exploiting 65,511 ha of the future reservoir area whose detailed forest inventory indicated a total of almost 20 million m^3 of round wood (without bark) of which 45.3 percent was considered with current commercial possibilities. A series of poor management practices and other problems resulted in the complete collapse of the company which in March of 83 saw its contract with the Ministry of Agriculture cancelled. The actual wood removed from the reservoir by CAPEMI has been a disputed figure but there is little doubt that it represents a very small part of its initial goal. Less than a month after the contract cancellation, the company went bankrupt.

IBDF, whose oversight responsibility over CAPEMI had been transferred to a special secretariat created in the Ministry of Agriculture, was charged after the company's collapse with the task of "promoting the regulation of the area to be deforested". Since CAPEMI had left behind a series of labor disputes in the area, IBDF ended up buying 1,208 m^3 of lumber and 216,140 m^3 of logs--much of which was still left on the forest floor--from CAPEMI for US$ 4.3 million* so that the company could pay the workers. Therefore, the possibility of labor riots was diminished. IBDF has resold only a small part of the wood it bought from CAPEMI, even after the reopening of legal log export--under certain conditions--a practice which had been banned in the mid-1970s.

IBDF then decided that any company could now enter the area and no royalty would need to be payed. The institute would only keep track of production by giving wood transportation licenses and exempting these

companies from reforestation fees usually charged to wood producers. Despite these favorable terms, few firms responded to IBDF's call to operate in the few months left before the formation of the lake. The dam was finally closed with most of the wood resources still left standing[3] in October 1984, four years later than it was originally expected (Goodland, 1978, 1983: 3-8; Sinal Verde, 1983a, 1983b; Hidroservice, n.d.; W.C. Corroa, pers. comm.; and S.J.F. Almeida pers. comm.). ELETRONORTE has contracted INPA and other scientific organizations in Brazil to study the ecological and environmental effects and control of the Tucuruí Reservoir. The agreement between INPA and ELETRONORTE is briefly described by Fonseca (1980: 243-4).

The second aspect of the Tucuruí hydroproject to be discussed here relates to the Araguaia-Tocantins watershed that "produces" the water to move Tucurui's turbines. There are three major rivers in this basin: (1) the 2,500 km long Tocantins River whose basin is in an area dominated by the Cerrado—a Savanna like vegetation—of central Brazil; (2) the 2,200 km long Araguaia River which meets the Tocantins a little after the city of Marabá and whose basin is in an area part tropical forest and part Cerrado; and (3) the Itacaunas River whose basin is covered by dense tropical forest. As a whole, the Araguaia-Tocantins watershed has 76,700,000 ha—of which 34,300,000 ha correspond to the Araguaia River basin. The northern one third of this watershed—which includes totally the Itacaunas basin—is covered by tropical forests while the other two thirds is dominated by the Cerrado vegetation of the Brazilian shield where a more pronounced dry season is observed

(ELETRONORTE, 1984: 19-2?, Goodland, 1978:2). This watershed is located in an area of the highest human activity in the region. The Belém-Brasília and Transamazonica Highways cross the basin and it is there that most cattle raising projects financed by SUDAM are located (specially on the Araguaia basin) as well as many spontaneous settlers. The presence of Carajás Iron Ore Project and related projects, combined with other factors discussed below indicate that this region is going to continue to be one of the most dynamic areas in the Amazon and with the largest conversion of the natural vegetation to other land uses.

Despite the known relationship between land use in a watershed and the rate of siltation of reservoirs and therefore useful life of hydroprojects, ELETRONORTE has given little thought to the need to consider the management of the Araguaia-Tocantins watershed. In 1978, Goodland was astonished that the sediment transported past Tucurui had not yet been measured (1978: 102). When asked about the expected useful life span of the project, ELETRONORTE officials still (early 1984) considered only the limitations of the civil construction and of the machinary. Little or no consideration has been given to the current rate of sediment transportation in the river, the likely rate of siltation of the reservoir, or the effects that the increased conversion of natural vegetation to other land uses will have on the useful life of the hydroproject.

Goodland (1978: 101-4) briefly raised this issue by giving several examples of siltation problems in other Brazilian hydropower stations as well as in other parts of South America. He recommended

that (1) measurements be made on the current rate of both suspended solids and bed load; (2) land use in the watershed be monitored; (3) the entire watershed should be zoned; and (4) general practices of good husbandry should be encouraged throughout the watershed. So far it seems that ELETRONORTE has paid little attention to the watershed management issue.

One of the reasons for this lack of concern may be related to the lack of an institutional arrangement to address this issue. In Brazil water resources administration is spread among several ministries and within a ministry in several organizations. An interesting approach that might be of some use for Brazil is the case of Colombia where Law no. 56 of 1981 requires that 2 percent of the gross income from hydroelectric projects has to be allocated into watershed management activities. This is an interesting approach because it associates directly electricity production with water production from the watershed in adequate quality and quantity for keeping or stretching the energy production capacity of hydroprojects (McGaughey & Gregersen, 1983: 130-2).

While the approach used by ELETRONORTE and the Ministry of Agriculture to deal with the wood resources of the Tucurui reservoir proved to be a failure, indications are that neither of the two organizations have so far learned much from the experience. ELETRONORTE is already building two other hydroprojects in areas of tropical forest in Amazonia and the wood resources again were forgotten until the last few years before the closure of the dam.

Both the Balbina and the Samuel hydroprojects had their preliminary studies initiated by ENERAM under its policy of supplying electricity to urban "development" poles. Basic projects for both began to be designed in early 1976. The Balbina hydroproject is located 146 km northeast of the city of Manaus on the River Uatuma, an affluent of the left bank of the Amazon River. Production from this hydroelectric is expected to begin in 1986. The 250 MW that it will produce will correspond to around 55 percent of the expected electricity demand in Manaus in the period 1986-1995. The Balbina reservoir will cover 165,400 ha of tropical forest containing an estimated average of 161 m^3 of round wood with no bark per ha. The average depth of the lake will be of only 7.8 m which indicate that most of the forest canopy will be exposed. Once again ELETRONORTE has been late in recognizing the existence of the wood resources of the reservoir area. It was only in 1983 that preliminary studies done by a consultant firm about the potential use of these resources were completed. Apparently ELETRONORTE has opted to once again try, although this time under its entire control, to have the area exploited by private sector enterprises. In late 1984 it announced in the major newspapers of the country that it was accepting applications for the exploitation of the wood resources of the Balbina reservoir. Time is certainly once again a major constraint since this company would have to operate in a very small period of time prior to the closure of the dam expected for 1986. As far as watershed management is concerned, ELETRONORTE may be in a better condition here since the 1,845,000 ha of

the Uatuma basin are still in a very unaccessible forested area whose chances for conversion to other land uses are presently slim.

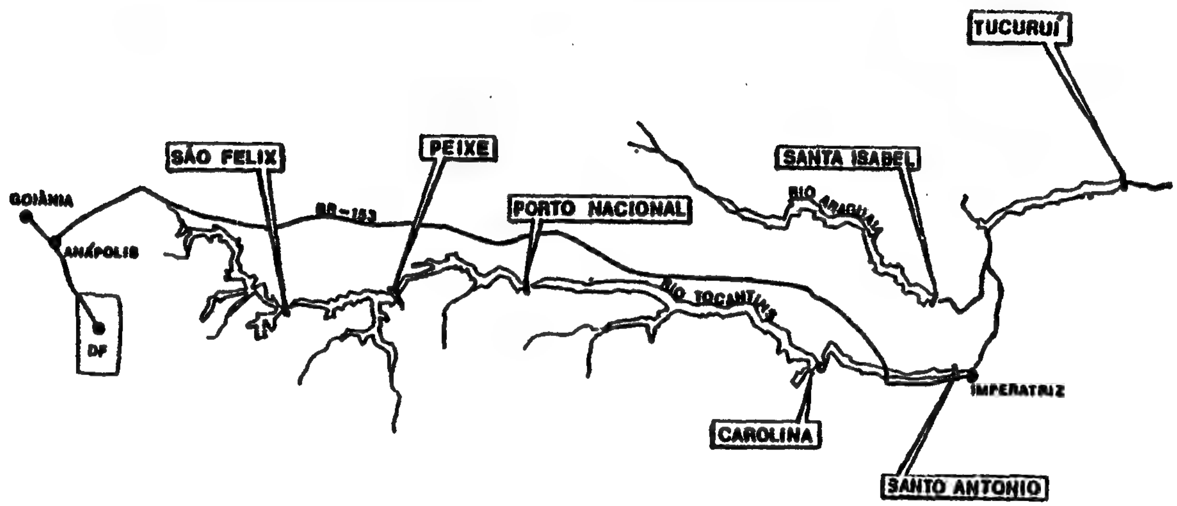
The Samuel hydroproject is located 52 km east of Porto Velho in Rondonia on the Jamarí River, an affluent of the Madeira River. Construction of this hydroelectric dam was initiated in March of 1982 and completion is expected for 1988. Samuel will have a capacity to produce 216 MW of electricity considered to be sufficient to supply 100 percent of the electricity demand expected for the period 1988-1993 in Porto Velho, Abuna, Grajará-Mirím, Ariquemes and Jí-Paraná in Rondonia; and Rio Branco, Acre's capital. Samuel will substitute completly the current oil-based thermolectric system. The Samuel Reservoir has 64,500 ha of tropical forest but data on the wood volume has not been available. Like the Balbina reservoir,the Samuel lake will also be very shallow, c.a. 7.0 m on the average. In early 1984, the same consultant company referred to above was undertaking a preliminary study of the potential use for the wood resources of the reservoir. Much like the Araguaia-Tocantins watershed, the Jamari basin is located in an area that has been suffering one of the highest rates of conversion from tropical forest to other land uses. The Porto Velho-Cuiaba highway follows the Jamari valley for nearly 200 km. The growing immigration of Southern minifundistas and landless poor to Rondonia combined with the land distribution activities of INCRA in the area since the late 1960s have resulted in large areas being converted to other land uses. This tendency indicates that it is advisible that ELETRONORTE be especially concerned with the proper management of the

Jamari watershed so as to prolong the useful life of the Samuel hydroproject. So far, like in the Araguaia-Tocantins watershed, ELETRONORTE has shown little concern with these aspects.

An interesting aspect of the Balbina and Samuel hydroproject should be brought up here. In both cases, ELETRONORTE is building large woodchip powered thermoelectric units. Those units are expected to produce 50 MW which is greater than the energy production of either the Coaracy Nunes or the Curuá-Úna hydroelectrics. These units are expected to produce for at least 20 years and initially will use wood harvested from the respective future reservoirs. However, their wood consumption per unit of time will not be high enough to exhaust the wood resources found in the areas before they are inundated (ELETRONORTE, 1978: 7; 1982; n.d.(b); Jaakko Poyry Engenharia, 1983).

The concerns with the environmental impacts of hydroelectric production and proper use of wood resources of the reservoirs in Amazonia do not end with these projects. ELETRONORTE has estimated that Amazonia has a potential for a installed capacity to produce 100,000 MW of electicity. ELETRONORTE expects Amazonia to become a major exporter of energy in the future. In fact, at least 4 other hydroprojects--Manso (210 MW), Santa Isabel (2,100 MW), Cotingo I (60 MW), and Porteira (750 MW)--are in an advanced phase of study. Meanwhile other preliminary studies continue to be executed throughout the region. Just on the Araguaia-Tocantins watershed, at least 5 other hydroprojects have been identified besides the Tucuruí and Santa Isabel projects as figure 56 shows (ELETRONORTE, 1983, 1984). It is hoped that

Figure 56: Map Showing the Location of the Constructed and Planned Hydroelectric Projects in the Araguaia-Tocantins Watershed.



Source: ELETRONORTE, 1983.

ELETRONORTE, in cooperation with IBDF, will design a process to address the issue of the wood resources located on the future reservoirs so that enough time is left to allow a reasonable chance for profitable exploitation. Also, watershed protection activities should be considered in the routines of hydroelectric power station's planning and management.

Notes for Chapter VII

1. "Concession, Forest Concession, Timber Concession ... Timber lease, license, or permit granted to a firm or person to extract and market timber or other produce commercially from a defined area of forest within a given period ... (Gray, 1983: 256).

2. Figueiredo also signed legislation which regulated the Brazilian National Parks (Degree no. 84,017 of July 21, 1979). By 1982, Brazil as a whole had a total of 24 National Parks (8,432,120 ha) and 10 Biological Reserves (1,133,096 ha) (IBDF, 1982b).

3. See note 25 for section V.3

4. This money had been allocated to IBDF by the Ministry of Agriculture as an emergency measure (Sinal Verde, 1983b).

5. ELETRONORTE payed three other companies to clearcut some 14,000 ha of the forest immediately in front of the dam and the wood material was barred on site. According to one of ELETRONORTE's officials, it was done for aesthetic reasons (Liberal, 1983).

CHAPTER VIII

Summary

This study examines the socio-economic development of the Brazilian Amazon Region and the past, current, and potential role of the forest-based sector in this process. For this purpose, the study is divided into three main parts.

The first part examines the Amazonian ecosystem in which human activities take place and are conditioned to it. Chapter II discusses the abiotic components of this ecosystem providing a general background on the natural history of the region, its current geology and geomorphology, its climate, the Amazon River Watershed, and its soils. Among other things this chapter includes discussions on the important role of the tropical forests in the water vapor cycling in the region. Also, it discusses the generally poor fertility of the Amazonian terra firme soils which limits the role of agricultural activities in Amazonia--especially of annual crops. Chapter III examines the biotic components of the Amazonian ecosystem and how they interact with their environment. It was found that tropical moist forests dominate the Amazonian landscape. These forests are very rich in species diversity and this chapter amplified this and discussed the paradigms developed to explain it. Also particularly important in this chapter is the explanation of the existence of the luxuriant tropical moist forest in Amazonia's poor soils by the description of several nutrient-saving

nutrients that have evolved through thousands of years. This chapter also includes a discussion of Amerindians as they existed before the arrival of the first Europeans. Amerindians are the only human beings who know how to survive in the tropical forest environment without destroying it and their proved methods are discussed in this chapter.

Part two of the dissertation discusses the Amazonian sociosystem concentrating on the region's development process and how the forest-based sector participated in it. Through a historical approach, it shows that the sector has been the most important in this process throughout the region's history, but more so before the 1960s. First with the <u>drogas do sertão</u>, then cacao, and starting in the 1850s until the 1910s, the most important of them all, rubber. All of those forest products had a fundamental role in the westward expansion of Brazil. After the fall of the rubber economy, Brazil-nut collection increased in economic importance, especially in Eastern Amazonia.

The fall of the rubber economy initiated a period of socio-economic decline in Amazonia, only briefly interrupted by the "Battle of Rubber" attempt to increase rubber production for the war effort. Only nearly a decade later would the federal government try to intervene in the economic decline of the region with the creation of SPVEA. Later in the 1950s, the construction of Brasilia and especially of the Belém-Brasília highway, would begin a new era in the region's development. Migration of landless peasants from other regions started in Amazonia during this period.

With the 1964 revolution, major changes were promoted in

Amazonia. Operation Amazonia was launched and SUDAM's fiscal incentives program began to heavily subsidize cattle ranching in the region, which expanded dramatically. With this expansion, deforestation also increased, and conflicts for land control between land grabbers, cattle raisers, rural migrants, and Indians escalated.

The changes in government corresponded to various policy changes for the promotion of Amazonia's development. In the early 1970s, the Medicí administration resolved to ignore all the historically unsuccessful experience of agriculture colonization in the region and its poor soils, to engage in the Transamazonica highway construction along which official agricultural colonization of poor northeast migrants took place. The same fate of the previous agriculture colonization attempts in the region also happened with this.

The new administration of General Geisel added a policy of growth poles, where government investment would be concentrated, and changed emphasis from official to private agricultural colonization. It was during this period that mining in Amazonia received greater emphasis, especially in the Serra dos Carajás mining region. With mining came the need for cheap energy. A program of hydroelectricity production started in the early 1970s with the Tucuruí hydroproject. However, the relationships of forests with hydroelectricity production were largely ignored.

The new administration of General Figueiredo concentrated his policies towards improve the role of mining activities in the region through the creation of the Greater Carajás Program. It also created a

new institutional arrangement for land affairs--through the creation of GETAT, and a new ministry, MEAF--so as to deal with the growing wave of migrants to the region as well as the increasing conflict over land control. For the case of Rondonia and northwest Mato Grosso, the Figueiredo administration created POLONOROESTE--a program to pave the Cuiaba-Porto Velho highway combined with an integrated rural development component.

Throughout the post-1964 revolution period the role of the forest-based sector in Amazonian development was largely ignored. This, in spite of unsuccessful attempts by both SUDAM and IBDF to created a forest policy for the region.

Part III of the dissertation examines closely the potential role of the forest-based sector in the Amazonian development. Chapter VI provides a framework for the understanding of this role, whereas chapter VII discusses 6 basic forest-based development issues identified as important for Amazonia.

It was also found that, if the sector is to improve its participation in Amazonia's development, a forest policy for the region--including definitions on how the forest ownership management, harvesting, industrialization, and marketing are to be divided between the public and private sectors--is necessary. Other institutional aspects such as forestry administration, research, education, extension, and financing--important for forest-based development in the region--were discussed. It was found that it is fundamental for the forest-based development of Amazonia that IBDF--or a more proper

organization--should have its administrative and planning capacity strengthened.

The growing deforestation in the region is quantified and ways to reduce it were discussed. Preserving samples of Amazonian ecosystems as a means to guarantee their perpetual benefit to humanity was also discussed. However, the most promising way to reduce deforestation in the region was found to be a better use of the tropical forest itself for the increase of income--in kind and money--for the rural poor. Forest-based colonization arrangements were suggested as alternative to the largely unsuccessful agricultural approach. The sector was also found to have a role in the acculturation process of the Amerindian population in the region. Finally, the relationship between forests and hydroelectricity are also discussed and it was found that ELETRONORTE should consider watershed management and wood salvage--from reservoirs-to-be--in planning and management of its hydropower program.

APPENDIXES

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Appendix 1: Acronyms

AEA- Associação dos Empresarios da Amazônia. (Amazonian Entreperneurs da Association).

ALBRAS- Alumínio Brasileiro S.A.

ALCAN- Aluminium of Canada Ltd.

ALCOA- Aluminium Company of America.

ALUNORTE- Alumina do Norte do Brasil S.A.

AMCEL- Amapá Florestal e Celulose S.A. (Amapa Forestry and Celullose Company).

AMZA- Amazônia Mineração S.A. (Amazon Mining).

APEC- Assessoria Promotora de Estudos Econômicos.

BASA- Banco da Amazônia (Amazonian Bank)-MINTER.

BB- Banco do Brasil (Bank of Brazil).

BCB- Banco de Crédito da Borracha (Credit Bank for Rubber).

BNDES- Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development).

BP- Before Present.

BR- Code for Brazilian federal roads.

CACEX- Carteira do Comércio Exterior (Exterior Commerce Agency)-BB.

CAEMI- Companhia Auxiliar de Empresas de Mineração (Auxiliary Company for Mining Enterprises).

CATIE- Centro Agronômico Tropical de Investigação e Ensino (Tropical Agriculture Research and Education Center).

CBA- Companhia Brasileira de Alumínio (Brazilian Aluminum Company).

CDE- Conselho de Desenvolvimento Econômico (Economic Development Council).

CEPLAC- Comissão Evecutiva do Plano da Lavoura Cacaueira (Executive Commission for the Cocoa Development Plan).

CETREMI- Centro de Triagem e Encaminhamento de Migrantes (Migrants Orientation Center).

CFI- Confederação Nacional da Industria (National Confederation of the Industry).

CIAT- Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture).

CIMA- Comissão Interna de Meio Ambiente (Internal Environmental Commission)- CVRD.

CNPq- Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Tecnological Development).

COBAL- Companhia Brasileira de Alimentos (Brazilian Company for Food)-MA.

COPLAN- Coordenadoria de Planejamento (Planning Division)-IBDF.

CPATU- Centro de Pesquisa Agropecuária do Trópico Umido (Agricultural Research Center for the Humid Tropics)-EMBRAPA.

CPPVEA- Comissão Parlamentar do Plano de Valorização Econômica da Amazônia (Parliamentary Commission for Amazonian Economic Support Plan).

CPRM- Companhia de Pesquisas de Recursos Minerais (Mineral Resources Research Conmpany)-MME.

CSN- Conselho de Segurança Nacional (National Security Council).

CVRD- Companhia Vale do Rio Doce (Rio Doce Valley Company)-MME.

DER- Departamento de Estradas de Rodagem (State Roads Department).

DNER- Departamento Nacional de Estradas de Rodagem (Nacional Department for Highways)-MT.

DNPVN- Departamento Nacional de Portos e Vias Navegaveis (Nacional Department of Ports and Navegable Vias)-MT.

EEC- European Economic Community.

ELETROBRAS- Centrais Eletricas Brasileiras S.A. (Brazilian Electricity Company)-MME.

ELETRONORTE- Centrais Eletricas do Norte do Brasil S.A. (North Brazil Electricity Company)-ELETROBRAS.

EMBRAPA- Empresa Brasileira de Pesquisa Agropecuaria (Brazilian Agricultural Research Enterprise)-MA.

EMFA- Estado Maior das Forças Armadas (Armed Forces High Command).

ENERAM- Comitê Coordenador dos Estudos Energéticos da Amazônia (Coordinator Committee for Energetic Studies in Amazonia).

FAO- Food and Agriculture Organization of the United Amazonia Nations.

FBC- Fundação Brasil Central (Central Brazil Foundation).

FIBGE- Fundação Instituto Brasileiro de Geografia e Estatísticas (Brazilian Institute of Geography and Statistics Foundation).

FIDAM- Fundo para Investimentos Privados da Amazônia (Fund for Private

Investments in Amazonia).

FIESP- Federação das Industrias do Estado de São Paulo (Federation of Sao Paulo Industries).

FINAM- Fundo de Investimentos da Amazônia (Fund for Investments in Amazonia).

FRR- Florestas Regionais de Rendimento (Regional Production Forests).

FUNAI- Fundação Nacional do Índio (National Indian Foundation)-MINTER.

FUPEF- Fundação de Pesquisas Florestais (Forestry Research Foundation).

GEAMAM- Grupo de Estudos e Assessoramento sobre Meio Ambiente (Environmental Studies and Advisory Group)-CVRD.

GETAT- Grupo Executivo das Terras do Araguaia/Tocantins (Executive Group of the Araguaia/Tocantins Lands).

IAN- Instituto Agronômico do Norte (Agronomic Institute for the North).

IBDF- Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forestry Development)-MA.

IBRA- Instituto Brasileiro de Reforma Agrária (Brazilian Institute for Agrarian Reform).

IBRD- International Bank for Reconstruction and Development-The World Bank.

ICOMI- Industria e Comércio de Minérios S.A. (Industry and Commerce of Minerals).

ICRAF- International Council for Research in Agroforestry.

IDB- Inter-American Development Bank.

IICA- Institute Interamericano de Ciencias Agricolas (Interamerican Institute for Agricultural Sciencies).

IIHA- International Institute of the Hilean Amazon-UNESCO.

INCRA- Instituto Brasileiro de Colonização e Reforma Agrária (Brazilian Institute for Colonization and Agrarian Reform)-MA.

INDA- Instituto Nacional de Desenvolvimento Agrário (National Institute for Rural Development).

INPA- Instituto Nacional de Pesquisa da Amazônia (National Institute for Amazonian Research)-CNPq.

INPES- Instituto de Pesquisas (Research Institute)-SEPLAN-PR.

IPEA- Instituto de Planejamento Econômico e Social (Social and Economic Planning Institute)-SEPLAN-PR.

KFW- Kredetanstalt fur Wiederaufbau.

MA- Ministério da Agricultura (Agriculture Ministry).

MEAF- Ministério Extraordinário para Assuntos Fundiários (Extraordinary Ministry for Land Affairs).

MECOR- Ministério Extraordinário para a Coordenação dos Organismos Regionais (Extraordinary Ministry for Regional Organizations Coordenation).

MIC- Ministério da Industria e Comércio (Ministry for Industry and Commerce).

MINTER- Ministério do Interior (Ministry of the Interior).

MME- Ministério de Minas e Energia (Mines and Energy Ministry).

MRE- Ministério das Relações Exteriores (Ministry of Foreign

Relations).

MT- Ministério dos Transportes (Ministry of Transportion).

NALCO- Nippon Amazon Aluminum Company, LTD.

NRC- National Research Council-US.

OTA- Office of Technological Assessment of the Congress of the United States.

PAD- Projeto de Assentamento Dirigido (Directed Settlement Project).

PDRI- Projeto de Desenvolvimento Rural Integrado (Integrated Rural Development Project).

PETROBRAS- Petróleo Brasileiro S.A. (Brazilian Petrolium Company).

PIC- Projeto Integrado de Colonização (Integrated Colonization Project).

PIN- Programa Nacional de Intergração (National Integration Program).

PMCFB- Programa de Monitoramento da Cobertura Florestal do Brasil (Brazilian Program for the Monitoring of the Forest Cover)-IBDF.

PNPF- Programa Nacional de Política Fundiária (National Program for Land Policy)-MEAF.

POLAMAZONIA- Programa de Polos Agropecuarios e Agrominerais da Amazonia (Program for Agriculture and Mineral Poles in Amazonia).

POLONOROESTE- Programa Integrado de Desenvolvimento do Noroeste do Brasil (Northwest Brazil Integrated Development Program).

PRODEPEF- Projeto de Desenvolvimento e Pesquisas Florestais (Forestry

Development and Research Project).

PROPASTO- Programa de Melhoramento de Pastagens da Amazônia Legal (Program for Pasture Improvement in Amazonia Legal)-CPATU-EMBRAPA.

PROTERRA- Programa de Redistribuição de Terras e Estímulo a Agroindustria do Norte e Nordeste (Program for Land Redistribution and Incentives for the North and Northeast Agroindustry).

PVEA- Plano de Valorização Econômica da Amazônia (Amazonian Economic Valorization Plan).

RDC- U.S. Rubber Development Company.

RODOBRAS- Comissão Especial de Construção da Rodovia Belém-Brasília (Special Commission For the Construction of the Belem-Brasilia Highway).

RRC- U.S. Rubber Reserve Company.

SAVA- Superintendência de Abastecimento do Vale Amazônico (Superintendency for Good Supply for the Amazonian Valley).

SEMA- Secretaria Especial do Meio Ambiente (Special Secretariat for the Environment)-MINTER.

SEMTA- Serviço Especial de Mobilização de Trabalhadores (Special Service for Labor Mobilization).

SEPLAN- Secretaria de Planejamento da Presidência da República (Planning Secretariat of the Presidency).

SESP- Serviço Especial de Saúde Pública (Special Service for Public Health).

SNAPP- Serviço de Navegação da Amazônia e Administração do Porto do Pará (Amazonian Navigation Service and Para Port Administration).

SPVEA- Superintendência do Plano de Valorização Econômica da Amazônia (Superintendency for the Amazonian Economic Support Plan).

SUDAM- Superintendência do Desenvolvimento da Amazônia (Superintendency for Amazonian Development)-MINTER.

SUDECO- Superintendência do Desenvolvimento da Região Centro-Oeste (Superintendency for the Development of the Center-West Region)-MINTER.

SUDENE- Superintendência do Desenvolvimento do Nordeste (Superintendency for Northeast Development)-MINTER.

SUDHEVEA- Superintendência da Borracha (Superintendency for Rubber Development)-MIC.

SUFRAMA- Superintendência da Zona Franca de Manaus (Superintendency of the Manaus Free-Trade Zone)-MINTER.

SUPRA- Superintendência de Política Agrária (Rural Policy Superintendency)-MA.

UFMG- Universidade Federal de Minas Gerais (Federal University of Minas Gerais).

UNEP- United Nations Environmental Program.

UNESCO- United Nations Educational, Scientific and Cultural Organization.

WWF-US- World Wildlife Fund-United States.

ZFM- Zona Franca de Manaus (Manaus Free-Trade Zone).

Appendix 2: Symbols Used.

AD: after death--Christian era.

Al: chemical element phosphorous.

BP: before present time.

cm: centimeter.

°C: centigrades.

Cr$: Cruzeiro, Brazilian currency.

Fe: chemical element iron.

ha: hectares = 10,000 m^2 = 2.471 acres.

k: chemical element potassium.

km: kilometer.

km^2: square kilometer.

m: meter.

m^2: square meter.

m^3: cubic meter.

mbar: millibar, a unit of barometric pressure.

Mg: chemical element magnesium.

mm: millimeter.

Mn: chemical element manganese.

mt: metric ton.

mw: megawatt.

N: chemical element nitrogen.

pH: potential of hydrogen. A measure of acidity.

ppm: parts per million.

US$: United States dollar.

Appendix 3: Public and Private Sector Organizations Visited During Field Trip (January to March, 1984).

BRAZIL

BRASÍLIA: IBDF, INCRA, GETAT, EMBRAPA, SEMA, SUDECO, FUNAI, ELETRONORTE, CNPq, MA, Exterior Relations Ministry, Planning Ministry, Greater Carajás Interministerial Council.

PARÁ: .Belém: IBDF, CPATU, SUDAM, BASA, Núcleo de Altos Estudos Amazônicos, Museo Paraense Emilio Goeldi, local wood-products industry.

.Monte Dourado: Jarí. Companhia Florestal Monte Dourado.

.Tucuruí: ELETRONORTE, IBDF's local office, Hydroelectric Power Station.

.Serra Norte: Carajás Iron Ore Project.

.Altamira: INCRA, IBDF's local office, Transamazonica Highway, Brasil Novo Colonization Project.

.Santarém: SUDAM's Wood Technology Center, Tapajós National Forest, IBDF's Commercialization Entrepot, SUDAM's Forest Experimental Station (Curuá-Úna), Curuá-Úna Hydroelectric Power Station.

AMAZONAS: .Manaus: IBDF, INPA, INCRA, EMBRAPA, SUFRAMA, State Government Land Agency, Wood-products industry.

.Itacoati ara: Wood products industry.

RONDONIA: .Porto Velho: IBDF, Samuel Hydroelectric Power Station, BR 364.

.Pimenta Bueno.

.Presidente Médici.

RIO DE JANEIRO: IBGE, Getulio Vargas Foundation, Economics Research Branch of the Planning Ministry.

UNITED STATES OF AMERICA

FLORIDA: .Gainsville: University of Florida's Center for Latin American Studies, Geography Department, and Forest Resources and Conservation Department.

WASHINGTON, D.C.: The World Bank, InterAmerican Development Bank, World Wildlife Fund-U.S.

Appendix 4: The Jarí Project[1]

This appendix will briefly discuss the Jarí Project--the first major commercial attempt at converting the tropical forest of Amazonia into tree plantations for fiber production. The project has been seen by some as possibly a model that could be repeated in other parts of the region.

The idea of the project was born in the mid-1950s when American shipowner and industrialist billionare Daniel K. Ludwig became convinced that a worldwide pulpwood shortage would happen before the turn of the century. Considered to be a man ahead of his time, Ludwig saw in this shortage an investment opportunity and decided to undertake a broad search for a fast growing tree species, a parcel of cheap land near a deepwater harbor, and a country with stable government and cheap labor to undertake a project. After some time and research, Ludwig found Gmelina arborea, a tree species native from India and Burma which had been successfully introduced in Africa and about which he became very enthusiastic. After being contacted by Brazilian officials, who had learned about the billionaire's plans, and a visit to President Castelo Branco who offered the government's support, he decided that Amazonia would be the best location for the project. In 1967, he bought c.a. 4,000,000 acres area crossed by the Jarí River--an affluent of the Amazon River--for just US$ 3 million located in

Northwestern Amazonia on the border between the state of Pará and the federal territory of Amapá. Labor was not readily available in the area but a system of contractors was arranged to bring workers from Northeast Brazil.

At age 70 Ludwig was in a hurry and soon after created the Company Jarí Florestal e Agropecuária Ltda. where he invested until 1981 c.a. US$ 1.1 billion. Without much on site experimentation, the company started clearcutting the terra firme tropical forest with bulldozers, then burning the trees, and initiated commercially scaled plantations of gmelina in the next rainy season. This mechanized clearing operation had been designed to save labor, but the soil compaction that the heavy machines caused resulted in poor sprout rates of the seeds. A more labor intensive clearing operation through the use of chainsaw and axes and less damaging to soil density was then used with more success.

This was not the only mistake made in the forest plantation part of the project. Gmelina, despite Ludwig's belief, was not an appropriate species for all 3 major soil types found in the area. Against the billionaire's will, one of the many managers that passed through the company decided to try planting Pinus caribeae var hondurensis, a species which had been tried before by SUDAM in the Curuá-Úna Forest Experimental Station with some success. After seeing the initial results of these experiments and after it was increasingly evident that gmelina was not an appropriate species for some areas of the project, he authorized the commercial planting of that species.

Despite this change, the rapid planting rate undertaken had created some 65,000 ha of gmelina by 1980. As of early 1984, of this total only 33,500 ha are considered satisfactory, whereas 20,000 ha have been abandoned due to slow growth, high death rate, and poor location (high slopes), and the rest has been converted to _Pinus caribeae_ or _Eucalyptus_ spp which have also been introduced more recently. Further reduction in gmelina productivity has been caused by a disease caused by the fungus _Cerathosystis fimbriata_ which is normally found in the native forest. Although this fungus does not affect pulp quality, it decreases growth rate which has happened to 22-30 percent of the existing gmelina plantations. Gmelina now is being planted only on relatively fertile (by local standards) clays and clay loan, _Pinus caribaea_ on loamy sand and sands, and _Eucalyptus_ spp on loans and infertile clays. By 1983, nearly 30,000 ha had been planted with pine trees while _Eucalyptus_ spp added over 28,000 ha.

Eucalyptus has been planted in Jarí because it became clear that gmelina's poor productivity severely compromised the ability of the company to have adequate wood supply to run the pulpmill. _Eucalyptus deglupta_ was first introduced in 1977 and, based on its initial good growth, commercial planting began in 1980. Like gmelina, this species was also found to be inappropriate for the area because after 3-4 years old growth rate decreased substantially. By late 1983, when this conclusion was being reached, the company had already planted over 25,000 ha with this species. Since the supply of the wood needs of the factory continue to be uncertain, a new species currently considered

promising is being planted: *Eucalyptus urophylla*. Other eucalyptus species are also currently being experimented.

Although pulpwood production is the main component of the Jarí project it is not the only one. Among others, Ludwig later also promoted (1) the raising of water buffalo (6,000 by 1983) in the várzea grassland areas located along the Amazon and lower Jarí Rivers; (2) the raising of cattle (5,800 by 1983) in savanna areas and later also in combination with pine plantations in an agroforestry pasture and tree plantation arrangement; (3) the planting of irrigated miracle rice (*Oryza sativa*) imported from the Phillipines in decked varzea area; and (4) a 500 metric ton/day Kaolin open-pit mine and processing plant--which officially was part of another company, Caulim da Amazonia S.A.--is also part of the project. Other mining operations are still possible to be developed, especially the bauxite deposits already measured.

But the principal activity was the production of pulpwood. With the good prices in the pulp market during the 1973-5 period, Ludwig felt confident on his expectations and ordered the plant to be built. The mill was financed by a Japanese export--Import Bank Loan of US$ 240 million guaranteed by the Brazilian Social and Economic Development Bank (BNDES). This loan guarantee was in fact a rare exception of BNDES' own rules against lending to foreign controlled firms, only possible because of President Geisel's special authorization. Constructed by the Japanese Engeneering firm Ishikawajima-Harima Heavy Industries, the 16 story high plant was

floated across oceans and the Amazon River to its final site—called Munguba—along the Jarí River where it was docked in April 1978. The 750 metric ton/day capacity bleached kraft pulpmill started operation in January of the following year. Energy for the pulpmill is provided by a 55 MW thermoelectric plant whose production, using natural tropical forest trees as fuel, is 76.5 percent consumed by the mill. The rest is consumed by a 2,000 m^3/month capacity sawmill[2], the Kaolin operation and urban areas of the project. This thermoelectric consumers around 2,200 metric ton of wood chip for fuel per day (20 hs).

To undertake the Jarí project Ludwig built an airport strip, a network of 6,700 km of roads, a 68 km railroad, the town of Monte Dourado with 8,500 inhabitants—where the headquarters of the enterprise is located with supermarket, schools, and hospital—, and other smaller forest villages[3].

Since gmelina plantations are not sufficient to supply the needs of the pulpmill and 2 other genera have been planted (*Pinus* and *Eucalyptus*) the company has been producing three different types of pulp along the years. As of early 1984, 152,000 metric tons of *Jaripulp*—a commercial name were produced per year with the consumption of gmelina complemented with Munguba—a native várzea tree species, *Bombax munguba*, used in larger proportion—and other native species. During the other part of the year, 57,000 metric tons of *Jaripine* were produced with the consumption of pine logs and Munguba and other native species. Eleven thousand metric tons and *Jarilyptus* based on the consumption of Eucalyptus and native species

were also produced. Most of this pulp production is being sold to Europe, with Asia and Latin America buying the rest.

The use of tropical forest trees for the production of energy (85 percent), as a complementary source of fibers for pulp production (15 percent), and for sawmilling (2 percent)[4] represent an annual deforestation of more than 1,400 ha per year. The need for the increased use of native tropical tree species has been a result of the reduced wood production caused by poor soils, disease, leafcutter ants (*Atta* spp.), and fire. Combined they have created a raw material crisis for the company.

But the problems faced by the company have not been limited to silvicultural ones. Labour turnover has been as much as 50 percent annually which represents increased costs in training, though worker wages are actually low. Turnover has not been limited to low payed workers, management has also suffered. Due to Ludwig's strong personality and the hardships of the location, during its first 12 years the project had at least (nobody is really sure about the actual number) 22 chiefs of operation. The project has suffered with this lack of continuity in supervision and direction and with waste of resource. Ludwig, however, until the early 1980s made sure that money was always available.

But it was poor public and government relations problems, however, that apparently resulted in the sale of the project to a consortium of Brazilian entreprenuers in early 1982. Up to 1979, Ludwig conducted his project with unnecessary high secrecy. The

activities of an increasingly unfriendly press--publishing reports of alleged mistreatment of low paid Brazilian workers, of the existence of such a large land area in Amazonia owened and run by foreigners, of environmental problems caused by the project--made the Jarí project controversial and politically unpopular.

The popular reactions to the project were reflected in the political arena through congressional investigations into it undertaken by both, the Senate and the Chamber of Deputies. After the presidential change of 1979, the government, which from the project's creation until that point had supported Ludwig, started to show signs of less cooperation. Among other events, the Figueiredo administration refused to support Ludwig's requests for government assistance to finance a second pulp and newsprint mill also to be built in Japan. The government also declined Jarí's proposal for the government to take over the responsibilities of providing several public services (medical, schools, police, housing financing) in company towns. In addition, the land titling situation of the property was not clear and the government apparently was doing little to clarify it to Ludwig's benefit.

Disgusted and exasperated by these events, Ludwig started to deactivate the project in 1980. The consequent lack of plantation maintainance and continuation of research resulted in further reduction in plantation productivity. This situation continued until late 1981 - early 1982 when Ludwig decided to sell the project to the Brazilian consortium. After the personal intervention of Brazil's President and

the Planning Minister, 22 Brazilian corporations--banks, insurance companies, contractors, and investment houses--, under the leadership of Amapá's manganese miner Augusto Trajano de Azevedo Antunes--also a close friend of Ludwig's--constituted a consortium to buy the project.

Antunes bought directly from Ludwig the kaolim operation for US$ 40 million which he then put as his share in the new consortium. The other participants added another US$ 60 million, while Bank of Brazil assumed the company's debt of US$ 280 million and put another US$ 100 million payable over 3 years. For its participation, Bank of Brazil would receive non-voting shares. In addition, 5 percent of the company's dividents distributed to stock-holders from 1987-1997, 4 percent for the next 10 years, and 3 percent until 2021 will be donated to the São Paulo Agency of Cancer Research Foundation, founded by Ludwig.

With the sale and a new name--Jarí - Companhia Florestal Monte Dourado--the project's America management was replaced by highly qualified Brazilians. The new management started a series of changes to decrease operational costs. They have succeeded in reducing these costs from US$ 12 million per month to US$ 5 million. Among those measures are the nationalization of previously imported equipments and parts, and the elimination of most of the company's subsidization of employees.

Operational costs are being further reduced by the decision of the government to supply some of the public services that it had previously denied to Ludwig. Although land control problems persist,

the government has also clarified the situation of 1,632,000 ha of the property which is much less than the size that Ludwig originally claimed. In addition, 2,500 of new tree plantations made in 1983 were, for the first time in the history of the project, financed with resources from IBDF's fiscal incentive program.

Plans for the second pulpmill have been suspended, so that management can concentrate on the immediate task of consolidating the company, paying its accumulated debt, and making sure that the mill does not have to stop for lack of raw material for energy or pulp production. Besides the absence of revenue, each hour that the plant is not operating costs US$ 14,000 to the company. In case a hydroelectric dam cannot be constructed to supply the electricity needs of the industrial complex, the plans of the new group include the formation of c.a. 40,000 ha of planted forests for fuel (wood chips) supply. Paralelly, with the cooperation of EMBRAPA, the company is researching the prospects for tropical forest management for fuel production based on clearcut operations.

The first year of the Brazilian management was difficult because revenues were much smaller than expected due to the low pulp prices in the international market. But prices have increased since August of 1983 leading the pulpmill to generate some operational profits.

The planted forests that the consortium received from Ludwig are not very productive for Brazilian standards. But the participation of Antunes in this project brought a new perspective in dealing with raw material shortage. Antunes may use the forests that he, in

partnership with American Scott Paper Company, have at about 100 miles east of Jarí in the federal territory of Amapá. Their company, Amapá Florestal e Celulose S.A.--AMCEL, had formed from 1977 until 1983 in converted savanna areas some 40,000 ha of Pinus caribaea var. hondurensis, half of the company's planned plantation goal.

Although the prospects for the Jarí project's success have so far apparently increased under the new Brazilian management, the long term economic feasibility of the project and its possibilities as a development model for Amazonia are still in doubt. A major group of related questions is still unanswered. Given the decrease in soil fertility and the existent and expected occurrence of diseases and insect problems, is large scale conversion of tropical forest to tree plantations economic and financially feasible? The project's experience seems to indicate that its profitability is more sensitive to changes of output prices than to diminished forest productivity with the correspondent increases in costs. So far one can only say that it is likely that there will be no other Ludwig to pour US$ 1.1 billion in this type of project. For the Brazilian consortium, however, whose investment represents only a fraction of the original resource allocated, this plantation project may turn out to be a good investment. The possible feasibility of tree plantations for the production of other wood products involving less capital intensive industrial investments--such as charcoal or firewood--may result in a greater rate of creation of forest plantations in the region, as has been proposed in the Greater Carajás Program.

The Jarí project experience has given few answers so far but at least has shown the financially rewarding benefits that research and close monitoring and control of this type of project in Amazonia (or the costs due to lack thereof) can generate. This is especially the case given the fact that most of the results of forestry research are site specific and are needed to be repeated on each site.

Notes for Appendix 4.

1. This appendix was prepared with information collected during a week long visite to the project site where company officials were interviewed (Jayme Mascaranhas Sobrinho - Forest Manager; Mario Diotto - Industrial Manager, Walter Dismann - Sawmill Manager, and João José Correa and Manuel Pedro Batista of the Research Division) as well as from the following published material: Briscoe, 1981; Fearnside & Rankin, 1980, 1982; Fraser, 1981; Hornick, Zerbe & Whitmore; Ianni, 1979; Jarí, 1983; Jordan & Russel, 1983; Kinkead, 1981; McDonald & Fernandes, 1984; Netto, 1982: 52; Taylor, 1984; The Economist, 1983; Time, 1979; Veja, 1984a, 1984b, 1984c.

2. Due to the limitations of the log chipping equipment (proper only for diameters less than 60 cm), the sawmill has to reduce some of the logs to dimensions that can be processed by the chippers. Consequently, reducing the diameter of large logs has become a high priority for the sawmill. Sawtimber production has been cut down to only 30-35 percent of the total sawmill capacity.

3. Two spontaneous riverside towns have been created as the project developed: Beiradão with 12,000 inhabitants across the river from Monte Dourado; and Beiradinho with 4,000 inhabitants across the pulpmill site in Munguba.

4. Up to early 1984, the company's research group had cataloged up to 536 native tree species in the project's area. So far 87 of these have been found good for cellulose production whereas 46 are used in sawntimber production. Most of the other species are used as fuel for the thermoelectric.

Appendix 5: Translation of Soil Taxonomy Terminology Used in the Humid Tropics Into Other Classification Systems.

Soil Taxonomy	FAO Legend	Brazilian Legend
Oxisols	Ferralsols	Latossolos, Terra Roxa Legitima
Ultisols	Acrisols and Dystric	Podzolico
Vermelho-Amarelo		
	Nitosols	
Inceptisols	(various)	Solos com Horizonte B
Aquepts	Gleysols	Solos Hidromorficos
Andepts	Andosols	--
Tropepts	Cambisols	Solos com Hor. B
Incipiente		
Entisols	(various)	
Fluvents	Fluvisols	Solos Aluviais
Psamments	Arenosols and Regosols	Regosols, Areias Quartzisosas
Lithic Phases	Lithosols	Litossolos
Alfisols	Luvisols	Podzolico
Vermelho-Amarelo		
	Eutric Nitosols	Equivalente eutrofico,
	Planosols	Terra Roxa Estruturada, Planossolos
Histosols	Histosols	Solos Organicos
Spodosols	Podzols	Podzols
Mollisols	Rendzinas Phaeozems	Brunizems
Vertisols	Vertisols	Grumusols
Aridisols (Saline)	Solonchaks	Solonchak

Source: Adapted from Sanchez, 1980 and NRC, 1982.

Appendix 6 : Vegetation Types of Amazonia According to IBGE.
(In thousands of hectares.)

Local	Total Surface Area	Humid and Super-Humid Forests: Amazonian: High	Amazonian: Terra Firme	Amazonian: Várzea and Igapó	Amazonian: Total	Extra-Amazonian: Subtropical	Cerrado	Campos	Others
Acre	15,259	-	13,465	1,736	15,201	-	-	58	-
Amapa	13,907	-	10,847	210	11,057	1,108	-	974	769
Amazonas	155,899	36,441	89,882	26,971	153,294	-	-	2,605	-
Para	122,753	-	108,187	7,478	115,665	-	-	4,789(5)	2,299
Rondonia	24,304	-	19,151	1,647	20,799	-	2,070	1,436	-
Roraima	23,010	-	16,634	658	17,292	-	-	5,718	-
Goias	28,579	-	3,192(2,3)	-	3,192	-	25,387(3)	-	
Maranhao	25,745	-	9,991(2)	-	9,991	-	12,426	2,565(6)	763(4)
Mato Grosso	88,100	-	50,467	-	50,467	-	29,419	662	7,553
Legal Amazonia	497,825	36,441	321,815	38,968	397,224	1,108	69,302	18,807	11,384
BRAZIL	845,648	36,441	321,815	38,968	397,224	11,857	172,928	41,769	232,620

Note: May not add due to rounding.

(1) Includes 268,000 ha of varzea in the area disputed between Amazonas and Para; (2) All terra firme forests of the state; (3) Assumes only two types of vegetation in the Amazonia Legal part of the state; (4) Half of the state's coastal vegetation; (5) Includes 1,456,000 ha of innundaded campo; (6) All of innundaded campos of the state.

Source: Modified from IBGE, 1981.

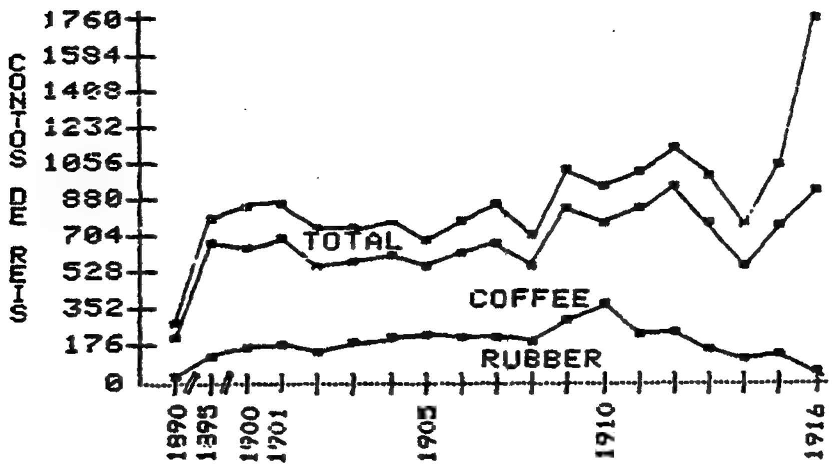
Appendix 7 : Population of Amazonas, Pará, and the Brazilian Amazonia, 1800-1920.

Year	Amazonas	Pará	Brasilian Amazonia
1800			90,000
1810		108,639	108,639
1818	19,350	123,901	143,251
1827	16,403	112,102	128,000
1840	19,570	109,530	129,530
1850	34,457	165,934	200,391
1860	46,187	232,063	278,250
1872	57,610	275,237	332,847
1882	115,114	274,883	389,997
1890	147,915	328,455	476,370
1900	249,756	445,356	695,112
1910	358,695	783,845	1,217,024*
1920	363,166	635,000	1,090,545**

* and ** Include the population of Acre Territory with 74,484 and 92,379, respectively.

Source: Adapted from Santos, 1980: 111, 317; Anderson, 1976: 250 cited by Weinstein, 1975b:27.

Appendix 8: Rubber and Coffee Participation in Foreign Exchange Earnings, 1890-1916.



Source: Adapted from Santos (1980: 290).

Appendix 9: Amazonian Rural, Urban, and Total Population and Growth Rate, 1940-1980.

Political Unit	Year	Total Number	Total Growth**	Rural* Number	Rural* Growth	Urban Number	Urban Growth	%
BRAZIL	1940	41,236,315		28,356,133		12,880,182		68.8
	50	51,944,397	2.3	33,161,506	1.6	18,782,891	3.C	63.8
	60	70,070,457	3.0	38,767,423	1.6	31,303,034	5.2	55.3
	70	93,139,037	2.9	41,054,053	0.6	52,084,984	5.2	44.1
	80	119,070,865	2.5	38,619,544	-0.6	80,479,448	4.5	32.4
North Region	1940	1,462,420		1,056,628		405,792		72.3
	50	1,844,655	2.4	1,263,788	1.8	580,867	3.7	68.5
	60	2,561,782	3.3	1,604,064	2.4	957,718	5.1	62.6
	70	3,603,860	3.5	1,977,260	2.1	1,626,600	5.4	54.9
	80	5,885,532	5.0	2,847,007	3.7	3,046,129	6.5	48.4
Pará	1940	944,644		657,779		289,865		69.6
	50	1,123,273	1.8	734,262	1.1	389,011	3.1	65.4
	60	1,529,293	3.1	914,320	2.2	614,973	4.7	59.8
	70	2,167,018	3.6	1,145,052	2.3	1,021,966	5.2	52.8
	80	3,410,088	4.6	1,742,206	4.3	1,669,662	5.0	51.1
Amazonas	1940	438,008		333,219		104,789		76.1
	50	514,099	1.6	376,363	1.2	137,736	2.8	73.2
	60	708,459	3.3	475,542	2.4	232,917	5.4	67.1
	70	955,235	3.0	549,404	1.5	405,831	5.7	57.5
	80	1,427,784	4.1	573,885	0.4	858,181	7.8	40.2
Rondonia	1940	..		..		..		
	50	36,935		23,119		13,816		62.6
	60	69,792	6.6	39,606	5.5	30,186	8.1	56.7
	70	111,084	4.8	51,500	2.7	59,564	7.0	46.4
	80	490.153	16.0	259,509	17.6	233,301	14.6	52.9

Appendix 9: Amazonian Rural, Urban, and Total Population and Growth Rate, 1940-1980 (cont.).

Political Unit	Year	Total Number	Total Growth**	Rural* Number	Rural* Growth	Urban Number	Urban Growth	%
Acre	1940	79,768		65,630		14,138		82.3
	50	114,755	3.7	93,483	3.6	21,272	4.2	81.5
	60	158,184	3.3	125,484	3.0	32,700	4.4	79.3
	70	215,299	3.1	155,992	2.2	59,307	6.1	72.5
	80	302,662	3.5	169,431	0.8	132,174	8.3	56.0
Amapá	1940	..		..		..		
	50	37,477		23,575		13,900		62.9
	60	67,750	6.1	32,956	3.4	34,794	9.6	48.6
	70	114,359	5.4	51,908	4.7	62,451	6.0	45.4
	80	175,442	4.4	71,708	3.3	103,926	5.2	40.1
Roraima	1940	..		..		..		
	50	18,116		12,984		5,132		71.7
	60	28,304	4.6	16,156	2.2	12,148	9.0	57.1
	70	40,885	3.8	23,404	3.8	17,481	3.7	57.2
	80	79,407	6.9	30,268	2.6	48,885	10.8	38.1

* Rural population is defined as that living in places with fewer than 2,000 inhabitants.

** Average annual percentage growth rate for the past 10 years.

% Percentage of the total population in rural areas.

Source: Compiled and computed from IBGE, 1981.

Appendix 10: Population of the Municipalities Containing the Amazonian State Capitals, 1950-1980.

Municipality/ State	1950	1960	1950-60 %*	1970	1960-70 %	1980	1970-80 %
Belém/ Pará	254,949	399,222	4.6	633,374	4.7	934,322	4.0
Manaus/ Amazonas	139,620	173,703	2.2	311,622	6.0	634,659	7.4
Macapá/ Amapá**	20,594	46,777	8.6	86,097	6.3	137,698	4.8
Porto Velho/ Rondonia	27,244	50,695	6.4	84,048	5.2	134,621	4.8
Rio Branco/ Acre	28,246	47,437	5.3	83,977	5.9	117,113	3.4
Boa Vista/ Roraima**	17,247	25,705	4.1	36,464	3.6	66,954	6.3

* Average percentage annual growth rate.

** Federal territory.

Source: IBGE, 1981 (Anuario Estatistico do Brasil).

Appendix 11: Surface Areas of the North Region and Legal Amazonia.

States and Territories	Area in the Legal Amazonia (1,000 ha)	Percentage in Legal Amazonia	Percentage of Legal Amazonia
BRAZIL	851,197	58.5	n.a.
Legal Amazonia	497,824	100.0	100.0
North Region	355,402	100.0	71.9
Amazonas*	155,899	100.0	31.3
Pará*	122,753	100.0	24.7
Rondonia	24,304	100.0	4.9
Roraima	23,010	100.0	4.6
Acre	15,259	100.0	3.0
Amapá	13,907	100.0	2.8
Mato Grosso	88.100	100.0	17.7
Goiás	28,579	44.5	5.7
Maranhão	25,745	79.3	5.2

Numbers may not add due to rounding.

* Does not include 268,000 ha to be demarcated between Amazonas and Pará.

Source: Modified from IBGE, 1981 (Anuário Estatístico do Brasil).

Appendix 12: Map of the Legal Amazonia (as of 1977).

Appendix 13: Small Industrial Projects Approved by SUFRAMA from 1977 to 1982*.

Industry	Number of Projects	Investment US$1,000	Investment percent	Employment Number	Employment percent
Forest-Based	29	1,834	37.5	470	33.1
Wood Products	28	1,671	34.1	459	32.3
Furniture	12	704	14.4	156	11.0
Lumber	4	647	13.2	156	11.0
Furniture/joinery	8	195	4.0	101	7.1
Miscelaneous**	4	147	3.0	46	3.2
Essential oils	1	163	3.3	11	0.8
Printing/Publishing	21	1,511	30.9	358	25.2
Metallurgy	21	742	15.2	227	16.0
Non-metallic minerals	15	265	5.4	182	12.8
Apparel	9	263	5.4	96	6.8
Beverages	2	51	1.0	16	1.1
Perfumary	1	33	0.7	8	0.6
Food	1	30	0.6	22	1.5
Miscelaneous	6	154	3.2	41	2.9
TOTAL	105	4,896	100.0	1,420	100.0

Numbers may not add due to rounding.

* These are the so called "projetos sumários" approved based on Resolution 111/77.

** Boats, back of trucks, coffens, tool handles.

Source: Calculated from SUFRAMA, 1983a.

Appendix 14: Realized Investment by SUDAM in the Period 1965-1983, by Sector.
(In U.S.$ 1,000 dollars of 1982.)

Year	TOTAL	Cattle	Agroind.	Industry	Sectorial	Services
1965	1,463	..	..	1,463	..	..
1966	9,910	1,412	..	8,497	..	..
1967	25,132	10,178	..	14,953	..	..
1968	52,759	21,747	61	21,066	..	9,885
1969	84,849	46,277	454	33,663	459	3,996
1970	162,594	81,204	1,535	57,596	2,821	19,438
1971	138,057	65,396	3,028	53,981	1,010	14,644
1972	111,535	62,377	966	38,342	1,168	8,683
1973	103,155	51,199	1,653	44,231	2,817	3,254
1974	107,758	53,332	3,330	46,664	3,886	547
1975	188,649	83,638	8,059	89,033	7,294	625
1976	156,850	72,894	6,621	61,089	10,377	5,870
1977	135,998	73,326	2,362	45,920	6,616	7,774
1978	147,821	67,107	3,657	57,073	5,748	14,236
1979	136,155	50,082	10,342	57,767	10,792	7.172
1980	124,339	48,755	3,501	66,673	1,990	3,419
1981	119,946	38,529	8,801	66,032	3,470	3,114
1982	144,807	46,671	11,523	73,805	4,332	8,476
1983*	111,746	42,015	12,007	51,481	2,298	3,945
TOTAL	2,063,521	916,135	77,897	889,328	65,079	115,079
Number of Projects	808	469	36	252	20	31

Numbers may not add due to rounding.

* Up to September, 1983.

Source: Computed from data provided by SUDAM.

Appendix 15: Number of SUDAM Cattle, Industrial and other Projects Implanted and Reformulated, and Total and Fiscal Incentives Invested in the Period 1975-1981. (In US$1,000 dollars of 1982.)

	1975	1976	1977	1978	1979	1980	1981
CATTLE							
Number of Projects							
Implan.	12	10	3	5	5	17	28
Reform.	27	30	30	36	36	35	57
Invest.							
Total	241,782	265,957	109,425	146,318	116,200	151,969	243,062
Fisc.Inc.	168,767	188,184	76,676	95,021	62,349	72,499	123,087
INDUSTRY							
Number of Projects							
Implan.	5	5	12	15	8	14	16
Reform.	22	14	17	22	27	25	28
Investment							
Total	309,639	128,299	266,645	419,632	201,248	168,001	453,563
Fis.Inc.	159,225	60,212	131,893	162,423	104,950	82,267	204,246
OTHERS							
Number of Projects							
implan.	..	6	5	5	3	2	2
Reform.	1	..	1	2	2	3	4
Investment							
Total	43,221	312,229	34,513	141,169	39,751	17,687	52,700
Fisc.Inc.	30,711	51,878	24,235	24,512	13,695	8,516	22,849
TOTAL							
Number of Projects							
Implan.	17	21	23	25	19	36	50
Reform.	50	44	50	61	66	65	92
Investment							
Total	594,642	706,485	472,377	728,954	382,491	390,256	818,297
Fisc.Inc.	358,703	300,273	265,687	292,872	189,756	196,303	384,878

Numbers may not add due to rounding.

Source: Computed from Anuário Estatístico do Brasil (various years).

Appendix 16: Realized Investment by SUDAM in the Period 1965-1983, by State.
(In US$1,000 dollars of 1982.)

Year	TOTAL	PARÁ	AMAZONAS	MATO GROSSO	GOIÁS	MARANHÃO	AMAPÁ	ACRE	RONDONIA	RORAIMA
1965	1,463	630	622	..	..	212	..	..	..	..
1966	9,910	6,070	543	603	..	994	1,699	..	..	..
1967	25,132	11,044	2,971	4,784	38	1,749	3,868	..	118	559
1968	52,759	19,554	5,024	21,362	1,998	3,116	1,333	242	35	96
1969	84,849	41,192	4,834	26,468	5,072	4,943	25	275	201	1,837
1970	162,594	61,633	19,285	61,007	8,687	6,333	1,545	3,252	..	849
1971	138,057	44,171	15,355	46,633	5,668	7,402	17,359	1,799	271	..
1972	111,535	31,616	13,585	46,722	4,761	6,652	7,153	781	266	..
1973	103,155	36,869	15,525	37,453	5,344	6,152	551	496	764	..
1974	107,758	29,578	18,028	43,854	5,656	6,302	2,422	284	1,634	..
1975	188,649	47,588	42,569	67,207	9,580	18,647	811	1,849	397	..
1976	156,850	44,247	29,527	58,478	9,948	10,539	861	1,223	2,023	..
1977	135,998	45,676	20,865	50,620	9,971	6,902	587	293	1,083	..
1978	147,821+	51,339	8,770	45,116	7,923	10,066	522	705	1,587	353
1979	136,155	49,665	33,421	28,960	11,330	8,744	252	2,791	684	309
1980	124,339	49,078	24,840	29,994	2,394	11,691	760	1,637	1,507	640
1981	119,946	49,318	23,960	33,882	2,434	5.126	1,920	1,565	994	806
1982	144,807	66,335	27,020	27,309	9,458	7,853	2,928	1,811	847	1,245
1983*	111,746	45,295	22,934	22,472	9,469	4,958	3,838	1,178	286	1,314
TOTAL	2,063,517++	730,897	329,618	652,327	109,733	128,382	48,436	21,981	12,696	8,009

Numbers may not add due to rounding.

* Up to September, 1983.

\+ The sum of this row is actually 126,381, but this number is wrong. Due to the level of detail of the original SUDAM data, it was not possible to trace the source of the error.

++ Due to the error mention in note +, the sum of this column is actually 2,042,078; which, for the same reason, is also wrong.

Source: Calculated from data provided by SUDAM.

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